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REPORT
OF
APPRAISAL OF MINING PROPERTIES OF MICHIGAN

1911

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APPRAISAL

OF

MINING PROPERTIES

OF

MICHIGAN

BY THE

STATE BOARD OF TAX COMMISSIONERS

Under provisions of Act No. 114, of the Public Acts of 1911.

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
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LETTER OF TRANSMITTAL.

Lansing, Michigan, August 21, 1911.

State Board of Equalization, Lansing, Michigan:

Gentlemen:—

Pursuant to the provisions of Act No 114, of the Public Acts of 1911, approved April 25, 1911, an appraisal and inventory of the mining properties of the State has been made under our direction, and we submit herewith the printed report of Mr. James R. Finlay, mining engineer of New York, under whose personal direction and supervision the work has been done.

The extent and magnitude of the work imposed under the provisions of the statute made the employment of an expert of recognized standing and ability an absolute necessity. Fitness for the work was the only qualification sought or required by the Board, and the only endorsements or recommendations given consideration were those coming from mining experts and educators having special and technical knowledge of the work to be performed.

After a thorough investigation and the most careful consideration of all those whose names had been suggested, Mr. Finlay was selected, and as soon as the preliminary details could be arranged, he entered upon the discharge of his duties. The selection of all the expert assistants was placed with Mr. Finlay and he was given full and complete authority regarding every detail of the work. Headquarters were established in the mining district and an efficient and well-equipped force was organized for the office duties. The appraiser and those working under him were given full and complete authority to call for and demand any and all information obtainable from the books, records, maps, etc., of the mining companies. In every instance access to all these sources of information was promptly and cheerfully given.

Appraiser Finlay gives in detail the result of the work done by him self and under his direction, and fully sets forth the methods adopted in arriving at the results.

Very respectfully,
James H. Thompson,
Robert H. Shields,
George B. Horton,
Board of State Tax Commissioners.

New York City, August 18, 1911.

Board of State Tax Commissioners of Michigan, Lansing, Michigan:

Gentlemen:—I respectfully submit herewith my report on the Appraisal of the various Mines of Michigan, with comments on certain properties which, at the beginning of the investigation, it was thought might be classed as mines, but which, at the end, I believed should be classed as manufacturing concerns.

I transmit herewith the following documents, which are the basis of my report, and should be considered a part of it:

1. 83 Copper Mine Reports and a card index, giving a list of all Copper Companies, and a guide to report numbers, as well as a record of correspondence on Copper.
   On these reports a memorandum of valuation is entered in red pencil, except in the case of the Quincy Mine, which made no report, all data on this concern being secured by personal examination.
   A Book of Charts of 5-Year Summaries of Michigan Copper Mines, taken from published annual reports.
   A Chart showing the record of money spent in the past five years by Copper Companies reporting, and their receipts from sale of Copper.
   Original Pencil Copy Maps and Tracings, showing ownerships along the Copper Belt. Numbers enclosed in circle on plats are used instead of the name of owners. For example: No. 36 indicates land owned by St. Mary's Mineral Land Company. On each Plat the name of owner will occur once, with the reference number.
2. 51 Reports of Iron Mining Companies, covering more than 100 mines, on which a red pencil memorandum showing the valuation of each will be found, also a Card Index.
   The alphabetical list on this Card Index refers to the card number of the mines. On this card will be found records of shipments and numbers referring to the companies' reports.
   Book of Blue Prints, showing ownerships of Iron Lands and location of ore bodies, by C. K. Leith.
   2 Lists of Ownerships of Iron Lands and descriptions of lands, by C. K. Leith.
3. Reports of Coal Companies.
4. 28 Reports by Salt, Cement, Gypsum, and Miscellaneous Companies.
   13 Plats of Salt Land Ownerships, covering 29 properties, with reports by C. W. Cook.
   3 Plats covering 9 Gypsum Ownerships, and reports by Horace F. Lunt.

24 Plats of Cement Ownerships, covering 22 properties, and reports by C. W. Cook.

8 Plats showing location of Limestone Quarries and ownerships, and comments by C. W. Cook.

5. 5 Files of Correspondence with various Companies and with my Assistants.
6. Complete Reports on Coal Lands and a report showing digest of information on Cement and Miscellaneous Properties, by H. M. Chance.

Dr. Leith's report on Iron Ore and Mr. Hagues's report on the Copper ores were both made in collaboration with myself, and the results are embodied in my own report.

Yours very truly,
J. R. Finlay.

APPRAISAL OF THE MINES OF MICHIGAN.

INTRODUCTION.

This work was undertaken under extraordinary conditions: I was notified on May 24th, 1911, that I had been selected by your Board, with the approval of the Governor and the Board of State Auditors, to appraise all the Mines of Michigan, including the Copper, Iron, Coal, Salt, Gypsum, and Miscellaneous, and hand in a report on their valuation before August 21st.

In some preliminary discussions I had become aware that it was considered necessary to have the work done under the general charge of an outside Mining Engineer, but it was not until I had arrived in Michigan that I became aware that Assistant Engineers, who were to look up the details in regard to mining properties, should also be outside men. It was not for some days that I fully realized that both the state of public opinion on matters of taxation and certain local feelings of rivalry and antagonism made it highly desirable that the whole work should be done by independent men from outside of Michigan. It goes without saying that this requirement added something to the difficulty of procuring precise information with the celerity that the shortness of the time seemed to demand.

It also made it plain from the very beginning that no examination of Mines in the ordinary sense could be attempted. Such an examination usually means a verification of the quality and quantity of ore remaining in the mines. To do this was plainly a physical impossibility.

The work therefore resolved itself into an examination of the essential records of the various mines. This not only seemed possible in the beginning, but proved to be possible, and I am able to submit a report on nearly all the mines, with full confidence that it is correct, barring minor inaccuracies due to hurry.

This would not have been possible except for the thorough-going cooperation of the mining companies themselves. Practically all of the concerns in Michigan which admitted themselves to be mining companies, showed a willingness to take great pains to furnish information fully and exactly, and to facilitate examination of maps and underground workings.

I was fortunate in being able to secure the services of the following gentlemen for various departments of the work:

Prof. C. K. Leith, of the University of Wisconsin, and formerly of the United States Geological Survey, for the Iron Mines. Dr. Leith has had broad experience with iron ores and their geology, not only in the entire Lake Superior region, but in various other parts of the world, and is a recognized authority on the subject.

Mr. William Hague, of New York, for the Copper Mines. Mr. Hague is Managing Director of the North Star Mining Company of California, is a thoroughly well trained Mining Engineer, and has had considerable experience in copper mining in the southwest. He was also equipped with a general acquaintance with the Lake Superior Copper Mines.

Dr. H. M. Chance, of Philadelphia, was employed to examine the Coal Mines, and also to study the question of what other mineral using concerns of the Lower Peninsula might properly be called mines. Dr. Chance was organizer of the Mining and Metallurgical Society of America, was formerly a Member of the Geological Survey of Pennsylvania, and has had a wide and thorough experience in Coal mining and allied industries.

Mr. Horace F. Lunt and Prof. C. W. Cook, of Ann Arbor, were employed to secure information about Coal, Gypsum, Salt, Cement, and Limestone properties in the Lower Peninsula.

Mr. Lunt is a Mining Engineer of Colorado Springs, Colorado, and Prof. Cook has made a specialty of the study of the salt industry of Michigan.

Mr. Heath Steele, formerly of Goldfield, Nevada, had charge of the correspondence and statistical work of the Houghton office.

Other employes in the capacity of Stenographers, Office-men and Assistants were Messrs. Schantz, Carson, Nellist, Paine, Pearsall, Grant and Culvertson.

All of these gentlemen exerted themselves to the utmost to secure the results required within the time limit and within the appropriation, and to them and to the Mining Companies themselves is due the principal part of the credit for making the work as satisfactory as it is.

It was plain from the outset that at least eighty-five per cent (85%), (and it was later proved to be more than ninety-five per cent (95%) of the industries that could properly be called mining, belonged in the Upper Peninsula, and on this account the principal office was established in Houghton.

From this office circulars were sent out to all the Mining Companies, requiring certain information. One of these circulars is reproduced in the discussion of the Copper Mines, and it will serve as a model for the others. The information asked for from all kinds of properties was substantially the same.

At an early stage of the work it became plain that most of the companies producing Salt, Gypsum, Cement, Limestone, Brick-clay, etc., did not consider themselves to be mining companies at all, and answered the circulars with reluctance. So many of them brought forward this contention that considerable attention was given to the subject, with the final result that all of my assistants in the Lower Peninsula, as well as myself, became convinced that they were right, and that these concerns were not, strictly speaking, mining companies, but merely manufacturers that use minerals incidentally. This matter is discussed fully by Dr. Chance in a report which is appended.

All of the gentlemen employed by me as assistants made voluminous reports, which I quote liberally throughout my report. None of these, however, can suitably be reproduced in full. Dr. Leith's report is largely a review of facts concerning the Iron Mines, hastily compiled and submitted without editing. His determinations of tonnages were necessarily based on certain conventional assumptions. For instance, the only additions he made to the tonnage reported in sight by Iron Mines was equal to one working level for such mines as showed no marked evidence of weakening. Dr. Leith does not regard such additions to be sufficient for the purpose of gauging the full future value of the properties, and merely used it for the purpose of showing an amount of ore that would not meet dispute anywhere. The substantial additions to tonnage I have made myself.

I quote Dr. Chance's report on the Coal fields in full, so far as it relates to general conditions.

RESULTS IN SUMMARY.

VALUATION BY COUNTIES.

Copper.

County.	
Keweenaw	$12,200,000
Houghton	57,315,000
Ontonagon	300,000
Total Copper	$69,815,000

Iron.

Gogebic District No. 1	$41,560,000	$41,560,000
Iron " No. 2	17,042,000	23,339,000
" No. 3	6,297,000	
Dickinson District No. 4	11,391,000	11,508,000
" No. 9	117,000	
Baraga District No. 5	335,000	335,000
Marquette District No. 6	12,132,000	
" No. 7	27,825,000	
" No. 8	2,530,000	
" No. 9	256,000	
		42,743,000
Total iron		$119,485,000

Coal.

Bay	$484,709
Saginaw	350,924
Midland	12,862
Tuscola	3,500
Shiawassee	9,750
Total coal	$861,745
Grand total	$190,161,745

These valuations are based substantially on past and present earnings. During the past five years profitable copper mines earned $50,937,690.27 over expenditures, but I consider these earnings abnormal, being mainly due to the great boom of 1906 and 1907. In 1906 these mines earned $21,093,000, but in 1910 only $7,075,000.

The iron mines earned in five years $57,551,202.06 without the benefit of any abnormal prices. In 1910, the earnings were higher than for the average.

The total valuation of the iron mines is $119,485,000 based on an expected annual tonnage for all the districts of 10,922,000 tons and a total estimate of ore reserve of 195,041,809 tons.

I feel justified in believing that while these tonnages are all that can be apportioned among the various properties with any degree of certainty, that the various districts can be counted on to produce ore somewhat as follows:

Marquette Range	150,000,000 tons
Menominee Range	150,000,000 tons
Gogebic Range	60,000,000 tons
Total	360,000,000 tons.

The reasons for these expectations are given to some extent in the comments on the various districts.

This is probably the first time any considerable valuation of Michigan iron mines has been made public. It will probably excite interest and the question will be asked: How nearly correct is it? My answer is that any man who concedes that it is logical to found expectations of the future on the results of the past will be forced to admit that these valuations are correct within a very moderate range of error. It is to be remembered that the factors of cost and price are established by official and authentic documents, and that the life of the mines is also mainly established by the same kind of documents. The whole range of error lies in the mere extension of life that I have adopted as reasonable beyond what is plainly measurable. Now since the question is one of present values, it is demonstrable that my error in these extensions must be simply enormous before the error in valuation becomes considerable. The life of the mines is admitted to average sixteen years. If I extend this life to twenty years, the increase of life is 25%, but the increase of present value is only 15%.

THEORY OF APPRAISAL.

This report is a calculation of the value of mines to the permanent owner for the production of minerals. It is based on three factors: 1st average cost, 2nd average prices and 3rd an estimate of future life. The first two factors are determined by experience. The third factor, the life of the mine, is based partly on developed ore and partly upon an assumption of continuance of known ore bodies beyond the present bottom levels of the mines. The assumption of continuance is based mainly upon the extent to which the continuity of the deposits has been proven for the district and for the type to which the mine belongs. It will be seen that these factors are quite as definite as those upon which calculations in the world of business are generally founded.

The future value of a series of dividends is reduced to a present value by the annuity method; that is, a sum is calculated upon which the series of dividends will pay five per cent interest and also provide each year a sinking fund instalment which, invested each year at 4% interest, and added to prior instalments similarly invested and reinvested, will equal the sum taken. This sum is the amount which an investor can afford to pay for the property.

TABLE OF PRESENT VALUES FOR A SERIES OF DIVIDENDS.

The following is a simplified table showing the present value on the above basis of a series of dividends for different periods.

A single dividend of $1.00 payable at the end of a year is worth.		$0 95
A dividend of $1.00 continuing	two years	1 85
" " " " "	three years	2 70
" " " " "	four years	3 50
" " " " "	five years	4 26
" " " " "	ten years	7 50
" " " " "	fifteen years	10 00
" " " " "	twenty years	11 96
" " " " "	twenty-five years	13 51
" " " " "	thirty years	14 74
" " " " "	thirty-five years	15 73

UNPROFITABLE MINES HAVE NO VALUE.

The reasoning from these factors is pursued to its consequences. No definite value can be placed on any property for which any of the factors cannot be determined. Whenever the working of a mine proves that expenditures will equal or exceed receipts from products at average prices, the property has no value at all and it is appraised at zero.

STOCK MARKET VALUATIONS NOT CONSIDERED.

It will be observed that this method makes no mention of quoted values. It may be asked, and is asked, why it is that if the products of mines are valued by the process of purchase and sale, the mines themselves should not be so valued? If the price of wheat, copper and iron is fixed by the sales on an exchange, why not mining stocks? My answer is that wheat is good to eat. Like copper and iron it is a staple and necessary article, tangible and definite. The value of these commodities is universally recognized, whether they are quoted on exchange or not, and prices fluctuate only with the varying pressure of demand. Mining stocks do not represent anything definite. Some pay dividends, in which case their quotations are comparable with those of other securities, but in the majority of cases mining stocks represent nothing more tangible than hopes. They fluctuate wildly as these hopes rise and subside. The very fluctuations make these stocks useful for gambling. People buy them not as serious investments, but as temporary speculations; often knowingly paying far more than they are worth, on the chance of selling them to somebody else for still more. In many cases this sort of thing has been organized into a business which depends not on any intrinsic value in the properties but wholly upon gambling. For this purpose the stocks are prized not because they are stable but because they are unstable. A notable instance of this is that of the famous Comstock mines of Nevada, which have scarcely paid a dividend in thirty years. On the contrary the assessments have reached astounding figures, probably over a score of millions. The assessments paid by stockholders merely take the place of prizes paid by lotteries, serving no purpose except to perpetuate the gamble. The public, of course, is fed with tales of the marvelous possibilities of these great mines and their past record is pointed to often enough. Still it is doubtful if much of these stocks is sold to a gullible public. They are mainly bought and sold by seasoned gamblers with whom it is a case of "dog eat dog." While this is an extreme case, it is wholly true that gambling forms an element to be reckoned with in every district where trading in mining stocks has become established. The copper district of Michigan is no exception. There are in it cases of terriffic fluctuations in stock values.. The Arcadian mine was valued at one time at $12,000,000; a few years later at $60,000, by stock quotations.

These reasons make it evident that the use of stock quotations in a serious appraisal of mining properties is illogical and beneath the dignity of a sovereign state. But, if the method is illogical it is certainly impracticable because in Michigan the ownership of mines by stock companies, whose shares are traded in, is confined to a single district—the copper mines.

The much more important iron mines are owned mainly by outside corporations or partnerships simply as so much private property. No available quotations apply to them even remotely. It is obviously necessary to use a method that will apply fairly to all properties throughout the state.

VALUATION OF MINERAL LANDS ON WHICH WORKABLE DEPOSITS ARE NOT DEVELOPED.

It is plain that where no deposits have been worked and not even proved to exist, the definite factors which can be applied to the valuation of an active mine are lacking. In this case no definite appraisal can be made. A figure only represents a guess. I can see no way to come to any conclusion about such lands, other than to attempt such an analysis of the facts as may limit the range between which guesses will be reasonable. In this connection it seems desirable to discuss one or two points of difference between mining and other forms of business.

The mining business may properly be distinguished on the ground that a nessential preliminary is the discovery of a deposit in the crust of the earth, that is inherently valuable. A sufficient quantity of rich gold ore in the remotest desert is valuable as soon as it is discovered. The *discovery* is valuable. The commercial problem of utilizing the ore can so certainly be solved that no one is much concerned about it. Such a deposit can only be valuable because it is limited in extent, consequently its size and the time it will last are points of great concern and a most essential factor in the value that can be put upon it. With minerals less valuable and more common—less valuable *because* they are more common—the commercial circumstances of a discovery play relatively a more important part. A copper mine in the interior of Alaska is not valuable unless it is large enough and rich enough to pay for a railroad to reach it. An iron mine in the middle of the Sahara would have no value at all even if a railroad ran across it. In other words an iron discovery to be valuable must be within the range of certain commercial conditions. The value of coal is still more a question of mere environment. It is so abundant and can be mined at so many places that the question of an assured market is far more vital to commercial success than the discovery of a seam of coal. When we come to still more common minerals, such as limestone, salt, gypsum and brick-clay we find that they are so enormously abundant that the discovery of them excites no comment whatever. It is doubtful whether the discovery of salt, for instance, is of any value. The ocean is full of salt. Deposits are known in Michigan which would apparently supply the whole world for thousands of years. The ultilization of such minerals, therefore, is wholly a commercial question, and I am disposed to draw a line between mines and other industries on the simple ground of whether the mineral rights on which they are based have value or not.

Many industries, which no one thinks of calling mines, use minerals and even mining processes. The Pennsylvania Railroad has for years been conducting the mining operations of shaft sinking and tunneling for the purpose of developing its terminals in New York City, but nobody calls the railroad a mine or New York a mining camp. Similarly we do not find a sufficient reason for calling the brick maker and the cement manufacturer miners because the first digs clay and the second dredges marl. If, however, brick clay were a limited product valuable enough to make the mere hope of its discovery on a tract of land a sufficient reason for placing a higher value on that land than it would otherwise have, then we might properly call brick making mining. Some distinction of this sort appears absolutely necessary in order to differentiate intelligently between mining and a vast group of manufacturing industries that use minerals.

There are in Michigan large tracts of land highly prized for their possibilities of containing valuable mineral deposits. These lands are mostly in the iron and copper regions of the Upper Peninsula. It has been a large feature of the work connected with this appraisal to tabulate the ownership and distribution of such lands, and attention has been given to the problem of working out a scheme of valuing them on a rational basis. The results will be taken up later in connection with the specific reports on the iron and copper fields. It is only worth while to point out here that the iron and copper ores of the Upper Peninsula have proved so valuable that their mere discovery carries a high commercial value. The mere chance of making such a discovery on a given tract of land is distinctly an asset. This is particularly true in the iron regions where the ores occur in masses of rock which are so unique that they can be instantly recognized, and in which the probability of discovery of merchantable ore is considerable. The finding of the "iron formation," therefore, can be considered a partial discovery of ore and it is undeniable that lands containing it have in the aggregate a large commercial value; a value that is not speculative but actual. But since we are now speaking of lands on which no merchantable discoveries have been made, we must admit that a valuation which may be reasonable for the aggregate of such lands may be wholly mistaken when applied to any particular tract.

MINING PLANTS NOT APPRAISED.

The value of a mine depends wholly upon the ore, that is, the equipment of a mine has no value except as applied to the ore. It is, therefore, useless to appraise mining plants as if they were in themselves an asset. It is true that a mine cannot be worked without equipment. A mine fully equipped is more valuable than a mere ore body without equipment, but this fact is fully taken into consideration in all appraisals. The point to be especially borne in mind is that mining equipment in itself is of no value; when the ore plays out the equipment is mere junk, no matter how costly it may have been in the first place; and this junk is so likely to be unsaleable that it is fully as likely to entail expense for watchmen and insurance as it is to yield any salvage. This fact may be surprising to many people but a little consideration will show that it is true. The equipment of a mine consists very largely of structures that cannot by any possibility be moved. The shafts and all other excavations are a part of the equipment. The buildings and machinery may occasionally yield some salvage but necessarily a small amount. It must be borne in mind that a large part of the expense of any installation of machinery consists of labor and materials for foundations, housing and erection. This is wholly lost when it is proposed to move the machine. Furthermore, the value of a machine depreciates rapidly on account of mere age.

MEANING OF APPRAISED VALUES.

The valuations in this report are intended to cover the value of the mining business of a company in each case. It includes all value that can be put on mineral lands and mining, milling and smelting equipment and mining supplies. It does not include property that can be valued for purposes other than mining, such as surface rights of any kind, agricultural or timbered lands, houses, stores, merchandise or cash.

EXAMINATION OF THE COPPER DISTRICT.

As soon as an office for conducting correspondence could be established at Houghton about June first, the work of securing information about the copper mines was actively commenced and an attempt was made, which proved entirely successful, to secure authoritative data on First—The Cost of Mining, and Second, the Prospects for Future Ore as Disclosed by the Maps of the Various Mines. Much information on the first subject could be gained by an examination of the published official reports of the various companies, the results of which were tabulated. To reinforce this information the following circular was sent to each of the copper companies, and similar ones to the iron, coal and miscellaneous mining companies.

BOARD OF STATE TAX COMMISSIONERS.
OFFICE OF APPRAISER OF MINES,
HOUGHTON, MICHIGAN.

CLASS—COPPER MINES.

Name of Company and officers.

Please answer the following questions in order and in case the company operates several separate mines, make answer separately for each of them, specifying the name of the mine.

1. How many men employed, include all classes up to General Manager.
2. What is the sum total of wages and salaries paid for each of the past five fiscal years.
3. Tons rock stamped for each of past five fiscal years.
4. Pounds of refined copper produced in each of past five fiscal years.
5. Price received in total dollars and per pound copper for all copper sold in each of the past five fiscal years.
6. Cost of production in dollars and per pound of refined copper for each of the past five fiscal years specifying the following items:
    a—Mining transportation and stamping.
    b—Exploration (diamond drilling, test pitting, etc., looking for new ore).
    c—Development (shaft sinking and opening work not charged directly to mining).
    d—Smelting, refining, freight and commissions.
    e—Construction (include all amounts spent on mining, milling or transportation equipment for the use of mines, but nothing for purchase of lands, real estate, etc.).
    f—General expense, (taxes, insurance, interest, administration and miscellaneous items not included in above).
    Total.
7. Describe, specifying township, range, section and sub-division of section, of each tract owned or operated by the company on which mining operations are now being conducted.
8. State how many tons of copper bearing rock and how many pounds of refined copper may reasonably be expected in future from each of these tracts.

9. Describe as above any tracts owned by the company known to contain payable copper rock, but which are not now being mined.
10. State how many tons of copper bearing rock and how many pounds of refined copper may reasonably be expected in future from these tracts.
11. Describe lands owned by the company which are situated upon recognized copper bearing formations, but which are not known to contain payable ore.
12. State ownership of company in other corporations connected with the copper business, such as smelting and transportation companies.
13. State ownership in acres, but without detailed description of nonmineral lands and other property not inherently a part of the mining business of the company.

Signature of President, Secretary or General Manager.

....

Mr. Hague examined the maps of all of the principal companies with great care. I examined them myself with less attention to details but sufficiently to verify the principal facts. Together we went underground in some of the mines for the purpose of checking at some points the accuracy of information supplied by the companies' documents. The circulars were replied to in a satisfactory manner, and I hand them to your Board, with comments in each instance.

The total result of our inquiries was satisfactory; for the information secured was quite sufficient to disclose the essential facts required for a valuation of the properties. I shall attempt nothing further here than to make a review of the conclusions arrived at.

PRICE OF COPPER.

For the purpose of appraising the copper mines, I have decided to apply to the future a price of 14 cents per pound. This is considerably above the price ruling during the summer of 1911.

The Calumet and Hecla Mining Company state that the actual sum received for all copper produced by that concern from 1878 to 1910 inclusive has approximately been 13½ cents per pound.

For the twenty year period from 1890 to 1909 inclusive the average price of a given amount of copper sold each year by the Quincy Mining Company was approximately 13.7 cents per pound. As there seems to be some evidence that the Quincy secures a slightly higher price than the other lake companies, this would give ground for taking 13½ cents as a fair figure.

The price fluctuates considerably, as will be seen from the accompanying table taken from Horace J. Stevens Copper Handbook, Edition of 1909. This table shows the product in pounds of the Lake Superior mines for the years 1890 to 1909 inclusive, the dividends paid by the various companies for the same years and the price reported by the Quincy Mining Company for these years.

Year.	Dividends.	Price Cents.	Product in pounds.
1890	$3,415,000	15.7	101,410,000
1891	3,540,000	12.8	114,223,000
1892	3,260,000	11.2	123,198,000
1893	3,520,000	10.4	112,605,000
1894	2,380,000	9.5	114,309,000
1895	3,280,000	10.1	129,331.000
1896	3,985,000	10.9	142,057,000
1897	5,431,000	11.1	142,703,000
1898	6,857,250	12.0	147,968,000
1899	12,318,450	17.0	146,950,000
1900	9,811,000	16.6	142,152,000
1901	7,496,000	16.1	155,717,000
1902	3,440,000	11.9	170,326,000
1903	4,980,000	13.2	192,299,000
1904	5,432,000	13.3	208,356,000
1905	9,224,000	15.8	230,438,000
1906	13,811,000	19.15	229,633,000
1907	13,469,000	18.04	216,117,000
1908	4,837,000	13.35	222,675,000
1909	6,309,000	13.2	220,000,000
Total	$128,796,200	274.34	3,262,464,000
Average	6,439,800	13.7	163,123,200

My own belief is that the average price of copper is tending to rise. This opinion is based upon some considerations much more complicated than the above. It appears that for the last fifty years the price has fluctuated widely. Periods of high prices have occurred at an average interval of about eight years, separated by intervening periods of lower prices. The average price of lake copper in 1864 was 47 cents; in 1870 it had fallen to 21.19 cents in 1872 it had risen to 35.56 cents; in 1878 it fell again to 16.56 cents; in 1880 it rose to 21.44 cents; in 1885 it fell again to 10.84 cents; in 1888 it rose to 16.78 cents; in 1894 it was 9.52 cents; in 1899 it was 17.76 cents; in 1902 it was 12.16 cents; in 1907 it was 20 cents; in 1910 it was 13 cents. From these fluctuations it is possible to argue that the price on the whole was falling from 1864 to 1894, but since that time it has tended to rise. Following the high price of 1899, the average fell in 1902 to 12.16 cents, but in 1910, following the much more severe panic and depression of 1907, the average price has gotten down only to 13 cents. It remains to be seen what the average for 1911 will be. One might assume from these figures that the price has risen at least 3 cents per pound since 1894 because, following the panic of 1907, the price has not fallen to within three cents a pound as low as it fell in the depression following the panic of 1893. It is also probable that another wave of high prices will culminate about 1915.

Furthermore, for the period of fifteen years, 1896 to 1910 inclusive, the average quotational price was 14.3 cents.

For ten years ending 1905 the average was.... 13.79 cents.
For ten years ending 1906 the average was.... 14.515 cents.
For ten years ending 1907 the average was.... 15.309 cents.
For ten years ending 1908 the average was.... 15.444 cents.
For ten years ending 1909 the average was.... 15.066 cents.
For ten years ending 1910 the average was.... 14.702 cents.

The trend of these figures is such that the stockholder in a long-lived copper mine has reason to hope that the average price for the future, taking a period of ten or twenty years, will be, perhaps, 15 cents per pound. My conclusion in 1909, after making a rather exhaustive study of the copper mining business, was that the average price for the ten years following would be 15½ cents per pound.

These figures and deductions seem to bear out the conclusion that a price of 14 cents is conservative for any mine that will last ten years. I have tried to avoid adopting a figure so high that it might be attacked as a mere personal opinion. Some copper companies believe that 13½ cents is a fair average and will perhaps be disposed to argue that 14 cents is unreasonably high. On the other hand I am convinced that even 14 cents is low and I am adopting it only from a desire to be conservative. The average for the five years reported for this appraisal was 15.3 cents. But this high average is explained by the effect of the abnormal prices of 1906 and 1907.

Much stress has been laid on the over-production of copper due to bringing in of numerous new mines during the past few years. The situation, however, is far from terrifying, as consumption is increasing at the rate of one hundred million pounds a year.

It appears that at the beginning of 1911, the expected increase of production from new mines would amount to some three hundred million pounds a year. This is only sufficient to meet the increase of demand for three years. After that period is passed the prospects for a scarcity of copper are fully as good as that new sources of supply will be added. The discovery of new deposits has practically ceased on the North American Continent. Even the so-called porphyry deposits which have been opened in the States of Utah, Nevada, Arizona and New Mexico within the past ten years are not strictly new. Their rapid exploration has been rather the result of finding how to treat them successfully. Since that was accomplished an urgent search has been made for further deposits of this type (which is not essentially different from that of the Lake Superior Copper Mines) but with no success.

Claims have been widely published by the promoters of these porphyry mines that they could produce copper cheaper than older mines in other districts. This claim will not stand analysis. So far as costs are concerned, the porphyry mines are in essentially the same situation as other mines. Some can produce copper cheaply and others cannot. It is highly doubtful if their average cost will be even as low as that in the Lake Superior District.

I recite these facts not to cast any doubt on the value of the new mines in the west, for they undoubtedly contain the greatest reserves of available copper known in the world today. But it is very easy to overestimate their effect on the commerce of the world. These new mines are not by any means so likely to disturb the copper business as the discovery of the Mesabi Range in the early 90s was likely to disturb the iron business of Lake Superior. For a few years after the opening of that remarkable district the supply of iron ore seemed so great that people had no confidence in its value and iron mines in Michigan were a drug on the market. The disturbance, however, proved to be of short duration and since 1898 the expansion in demand for iron ores has not only absorbed the enormous production of the Mesabi Range but has actually allowed the older mines to increase their annual production 50 per cent.

THE PAYING COPPER MINES.

Only nine copper companies in Michigan have made money during the past five years. Their actual earnings were $50,937,690 with copper averaging 15.3 cents per pound. Had the metal averaged 14 cents the earnings would have been $41,200,000. This would be $8,240,000 a year. The following tables give details of the cost, production and profits of these mines for the past five years and an estimate of their probable future production and present value.

Five year Operating Results of all Michigan Copper Mines whose record indicates them to be Profitable in Future.—J. R. Finlay's Report August 19, 1911.

Company.	Expenditures.				Cost per lb. cu.	Average price per lb.	Profit.	Loss.
	Construction.	General.	Miscellaneous expense.	Total expense.				
Calumet & Hecla	$2,889,570 00	$2,237,379 00		$36,662,696 00	08.95	15.8	$24,650,479 00	
Mohawk	Incl. general	285,943 26		5,940,140 74	11.35	14.85	1,850,260 52	
Ahmeek	1,226,945 33	145,192 24	(a) $335,242 71	4,786,018 00	13.30	14.30	348,758 79	
Allouez	702,950 89	Incl. Const.		2,942,995 59	17.00	16.00		(b) $157,928 88
Wolverine	125,949 62	Incl. Const.	(c) 153,361 00	3,675,517 93	07.65	15.60	3,896,270 59	
Osceola Consolidated	562,220 48	Incl. Const.		10,228,103 47	10.53	15.2	4,852,280 14	
Quincy	747,659 00	Incl. smelting		(d)11,433,086 00	11.30	15.45	4,355,362 00	
Isle Royale	945,681 48	Incl. Const.		3,906,541 73	17.80	14.20		(e) 619,852 61
Superior	75,913 00	140,210 00		1,201,727 00	19.20			695,804 00
Baltic	543,092 01	268,948 46		7,479,161 52	8.9	14.8	5,093,564 76	
Tri-Mountain	151,906 71	217,835 92		4,458,417 36	12.8	15.6	1,042,062 09	
Champion	751,395 09	333,626 57	Interest 26,062 20	8,155,488 10	9.25	15.+	5,097,141 83	
Lake	161,719 00	58,341 00	Exp. and Dev. 223,719 00	472,256 00		18.2		468,488 06
Atlantic			Exploration. 372,458 24	372,458 24				372,458 24
Total	$8,885,002 61	$3,687,476 45	$1,110,844 15	$101,714,607 63	10.1	14.98	$51,186,279 72	$2,314,531 79

(a) Development not charged to mining.
(b) Not a loss if stamp mill item not included.
(c) To cover over estimate of value of copper previous year.
(d) Purchase of lands not included.
(e) Purchase of lands included. Cost of Copper per lb. about 16.7 cents if not included.

Five year Operating Results of all Michigan Copper Mines whose record indicates them to be profitable in Future.—J. R. Finlay's Report August 19, 1911.

Company.	Years.	Pounds of copper produced.	Tons rock stamped.	Yield per ton. lbs. cu.	Receipts.			Expenditures.	
					Sale of copper.	Other sources.	Total receipts.	Mining, transportation and stamping.	Smelting, etc.
Calumet & Hecla	5	410,614,189	13,185,376	31.2	$61,313,175 00	....	$61,313,175 00	$26,850,772 00	$4,684,975 00
Mohawk	5	52,415,939	3,566,699	14.7	7,776,689 48	$13,711 78	7,790,401 26	5,654,197 48	Incl. mining.
Ahmeek	5	35,911,797	1,722,281	20.9	5,134,776 79	....	5,134,776 79	2,666,833 01	411,804 71
Allouez	5	17,355,301	1,114,085	15.6	2,762,507 89	22,558 82	2,785,066 71	2,240,044 70	Incl. mining.
Wolverine	5	48,163,660	1,799,273	26.7	7,521,329 09	50,459 43	7,571,788 52	3,396,207 31	Incl. mining.
Osceola, Consolidated	5	98,617,221	5,781,808	17.2	14,663,437 44	416,946 17	15,080,383 61	9,665,882 99	Incl. mining.
Quincy	5	101,620,255	Not given	Approx. 16.	15,681,637 00	106,811 00	15,788,448 00	9,735,008 00	950,419 00
Isle Royale	5	21,902,821	1,508,740	14.6	3,117,242 61	169,445 51	3,286,689 12	2,960,860 25	Incl. mining.
Superior	5	6,278,707	287,126	21.8	505,922 00	(f)	505,922 00	897,032 00	88,572 00
Baltic	5	84,194,877	3,771,016	22.3	12,572,826 28	....	12,572,826 28	5,772,872 57	894,258 48
Tri-Mountain	5	34,710,824	1,926,936	18	5,500,479 45	....	5,500,479 45	3,667,528 38	421,146 35
Champion	5	88,460,380	3,651,132	24.2	13,252,629 93	....	13,252,629 93	6,093,677 69	950,725 55
Lake	3	318,050	14,847	21.5	(g) 3,767 94	(f)	3,767 94	25,982 00	2,495 00
Atlantic	5	....	....	....	....	....	....	....	....
Total	....	1,000,564,021	38,329,319	26.2	$149,806,420 90	$779,932 71	$150,586,353 61	$79,626,898 38	$8,404,386 09

(f) From report to Tax Commission and not from annual reports.
(g) Unexplained.

If we could assume that these mines would last forever the investor would probably be satisfied with 5% income and he would probably capitalize their average earnings of $8,240,000 into a present value for the group of $164,800,000. The fact is that these mines are not worth even half of this amount, because their future life is not by any means perpetual. On the contrary their future is much less promising than it is popularly supposed to be. These mines have shown unusual persistence in depth but the limit of profitable working is now in most cases in plain sight. It must not be forgotten that the tonnage maintained now is three times as great as the mines have averaged in their fifty years of life. It will be observed that the Tamarack mine is not in the list of profitable companies. This mine has become worthless because the Calumet conglomerate, by far the richest deposit in the whole district, has failed in depth. The Tamarack owns an irregular tract immediately below the Calumet and Hecla mine and including the whole downward extension of the great lode which has enabled that property to pay $115,000,000 in dividends. In the upper portion of its mine the Tamarack was able to earn handsome profits and it paid up to 1906 a total of $9,420,000 in dividends. Since then it has uniformly lost money because the rock no longer yields enough copper to meet expenses. The depth at which the lode became unprofitable was approximately 8,000 feet on the slope. If this richest of all the deposits has played out in this manner it may be taken as a sure inference that inferior lodes will play out at lesser depths.

In order to give a more comprehensive view of the whole situation, I shall describe briefly the principal deposits which are now being worked with success. There are only six lodes supporting profitable operations, namely, the Kearsarge, Osceola, Pewabic, Isle Royale and Baltic amygdaloids and the Calumet conglomerate.

KEARSARGE LODE.

Beginning at the north east end of the district we have first the Kearsarge Amygdaloid, on which are situated the Mohawk, Ahmeek, Osceola Consolidated, Allouez, Wolverine and Centennial mines. This is the longest lode in the district. It dips northwestward at an angle of about thirty-seven degrees. Its thickness is some twelve feet. Its length is five miles. While this vein is mineralized quite uniformly for the above length there are two areas or ore shoots that are distinctly richer than the average. These occur on the Wolverine and Ahmeek properties. These two enrichments appear to be substantially of the same size and character, but apparently the Wolverine ore body is the richer.

The Wolverine has been able to maintain a yield of about twenty-seven pounds of copper per ton, but there has been some decline. At first the rock yielded thirty pounds but it has now gone down to about twenty-five pounds per ton. The conditions for cheap mining are ideal and the Wolverine has been able to produce the cheapest copper of the district, its cost per pound being less than 8 cents. The Ahmeek mine is much younger and is just arriving at its most profitable stage. It has been securing about twenty-two pounds refined copper per ton and has brought its tonnage up to about 550,000 a year. I calculate that this mine will have to spend considerable money for further construction and development in order to bring its output up to some eight hundred thousand tons per year. Including the probable expenditures for construction, I estimate that the mine can produce copper at slightly over nine cents a pound for the next ten years.

The other mines on this lode are not so good, although the South Kearsarge branch of the Osceola Consolidated seems to have a portion of the Wolverine ore shoot. We may calculate with certainty that part of the Kearsarge lode will prove profitable down to a depth of at least six thousand feet. It is not an unfair supposition that at least 60% of its area would be mined to that depth and will produce sixteen pounds per ton. Mr. Hague has estimated that at a depth of two thousand feet on the slope the lode is yielding an average of eighteen pounds a ton but that the yield may be expected to diminish with greater depth.

It is probable that the lode will be able to produce to a depth of six thousand feet some ninety million tons of ore, of which some twenty million tons have already been mined. This would leave seventy million tons to be taken out.

The tonnage apportioned among the various properties is as follows:

Wolverine	3,600,000 tons.
North and South Kearsarge	21,000,000 tons.
Centennial	Doubtful.
Mohawk	12,000,000 tons.
Allouez	10,000,000 tons.
Ahmeek	17,000,000 tons.
Total	63,600,000 tons.

The distribution of copper still to be produced is as follows:

Wolverine	80,000,000 pounds.
Osceola Consolidated	300,000,000 pounds.
Mohawk	176,000,000 pounds.
Allouez	140,000,000 pounds.
Ahmeek	290,000,000 pounds.
Total	986,000,000 pounds.

This is probably as near correct as a tonnage can be apportioned among the divided owners.

The valuation put on these various mines is as follows:

Beginning at the North End.

Mohawk	$3,500,000
Ahmeek	7,200,000
Allouez	1,500,000
Wolverine	3,700,000
Osceola Consolidated	6,000,000
Total	$21,900,000

The method of arriving at this apportionment is as follows:

The Mohawk Mine has a surface area covering the Kearsarge lode of about 480 acres, this being the upper portion from the outcrop down to the Ahmeek line, which will be reached at an average depth of 2,500 feet along the slope. About 70% of the territory so far explored appears to be mineable and yields about 55,000 tons of ore or approximately eight hundred thousand pounds of copper per acre. On this basis approximately 330 acres containing two hundred and sixty four million pounds of available copper was the full measure of production possible in this territory before mining began. About eighty-eight million pounds has been already removed, leaving for the future a product of about one hundred and seventy-six million pounds. This can be mined in approximately fifteen years at a cost of eleven cents a pound and a profit of three cents a pound, giving a total profit of $5,280,000 and a present value of $3,500,000.

Going now for convenience to the Wolverine Mine we find that it has a surface area covering the lode of about 215 acres. The total production to date has been approximately one hundred and seven million pounds and the future production will be eighty million pounds. This can be mined in nine years at eight cents a pound, leaving a profit of six cents a pound and a total profit of $4,800,000, and a present value of $3,700,000.

The fairest method of measuring the probabilities of the Ahmeek Mine is to compare it with the Wolverine and Mohawk combined. The reason for this is that the Ahmeek contains, as mentioned above, a rich portion of the vein comparable to that of the Wolverine, but not so rich. It contains only twenty-two pounds of copper per ton against twenty-seven pounds for the Wolverine. A large part of its territory is simply a downward extension of the lode from the Mohawk property.

The total area of the Ahmeek property covering the Kearsarge lode above a depth of six thousand feet on the slope is 660 acres against a combined acreage of 695 acres for the Mohawk and Wolverine. I do not believe that the Ahmeek property is likely to produce more than 75% as much copper as the two properties combined. The rich tract is approximately 80% as rich as the Wolverine. The portion underlying the Mohawk has the pronounced disadvantage of containing only the deep levels. I, therefore, base my valuation of the Ahmeek Mine on the assumption that it will produce three-quarters as much copper as the Mohawk and Wolverine combined. This will give us about three hundred and thirty-five million pounds of which forty-five million pounds have been mined, leaving two hundred and ninety million pounds to be extracted. It is a fair assumption that of this, one hundred and fifty million pounds will be produced during the next ten years at an average cost of a trifle over nine cents a pound, making a total expected profit in that period of about seven and one-half million dollars and a present value for that period of about five and one-half million dollars. The remainder, one hundred and forty million pounds, will probably be low grade, costing eleven cents a pound and making a profit of $4,200,000 for a period of twelve years following the first ten. The present value of such an expectation is about $1,700,000, so that the maximum valuation of the Ahmeek is $7,200,000.

The Osceola Consolidated owns the North and South Kearsarge mines.

The South Kearsarge is rich like the Wolverine, but it is largely worked out. The North Kearsarge is poor like the Mohawk. Without going into details, the total expectation is about twenty-one million tons containing about three hundred million pounds of copper. This can be mined in fifteen years at a profit of three cents a pound, totaling nine million dollars. This would give it a present valuation of approximately six million dollars.

The only remaining mine on the Kearsarge lode that can be classed as profitable, the Allouez, may be counted on for about ten million tons and one hundred and forty million pounds of copper. The operating record to date of this mine is not very flattering, costs for the past five years being fifteen cents; but in 1910 it got down to 11.6 cents. This mine has only two shafts, which gives it a maximum producing capacity of four hundred thousand tons a year. At this rate it will take twenty-five years to exhaust the property, and it is not safe to count on the cost of copper at less than twelve cents a pound. We have then a total of $2,800,000 profit to be expected in twenty-five years. This gives the mine a present value of only $1,500,000.

OSCEOLA AMYGDALOID LODE.

Only one mine is working on this lode at present, viz.: the Calumet & Hecla. On this property it has been developed for a length of 9,900 feet, but a considerable portion at the North End is not apparetly profitable. Since December, 1900, this lode has produced 3,301,766 tons. The abandoned extension on the Old Osceola mine toward the south is supposed to have produced about four million tons. The yield of copper on Calumet & Hecla ground alone has been about fifty-five million pounds. This vein is not as uniform as the Kearsarge. Mr. Hague summarizes the situation as follows:

> "From the fact that the Osceola lode in the Tamarack workings shows a yield of about 13 pounds per ton at depth of 6,100 ft. on the dip of the lode, and from the fact that the Osceola branch of the Osceola Con. has been closed, the lowest workings being 4,700 on the dip of the vein,—an arbitrary limit of 5,000 ft. has been placed upon profitable mining on the Osceola lode—providing the price of copper remains the same, and provided that no material reduction in working costs takes place while operating at such depth."

On this basis and assuming that 60% of the lode will prove mineable it is estimated that it will yield some twenty-three million tons, which will produce 330,000,000 pounds of copper. This will be produced in twenty years at a cost of eleven cents a pound, giving the mine a present value of $5,900,000.

THE CALUMET LODE.

This is the single conglomerate vein worked in the district. It is by far the richest in the whole region and has paid nearly 70% of all the dividends of the Michigan copper mines. It has been worked by the Calumet & Hecla and Tamarack companies. The Tamarack as mentioned above has become unprofitable on account of great depth and the Calumet & Hecla has its possible future sharply defined. This fact is ominous for the prosperity of the district as a whole for the failure of this great deposit is not being compensated for by new discoveries.

The Tamarack Mine has no payable ore at all in sight and I appraise its value at zero.

The Calumet & Hecla has on its conglomerate lode about twenty-seven million tons of ore reasonably assured at an average estimated content of twenty-six pounds per ton, making a total of 702,000,000 pounds. The tonnage is divided roughly between five million tons of shaft pillars, estimated to contain fifty pounds per ton and twenty-two million tons of other rock in the lower portions of the mine estimated to contain only a shade over twenty pounds per ton. These figures contrast sharply with the former richness of this deposit, for ten years ago the average yield of the Calumet & Hecla rock was sixty pounds per ton.

Great progress has been made in reducing costs. The mine was excellently equipped with magnificent machinery during the bonanza days and this machinery has proved ample for the ultimate requirements of the property. The development work required to extract the ore has been largely completed. As a consequence, I believe the mine can be worked out at a great profit until it is exhausted. I estimate for the remaining copper a cost of only nine cents a pound, which will leave a profit of five cents. This will give the property a profit of thirty-five million dollars in twenty years on this lode, giving it a present value of twenty-one million dollars. The company also claims, and I have no reason to doubt, that it can produce one hundred and fifty million pounds of copper from some thirty million tons of conglomerate sands now piled in Torch Lake. This can be produced at about nine cents a pound during the next twenty years, the present value being not less than $4,500,000. The total value to be credited to the conglomerate lode, therefore, at the present time is about $25,500,000. For the whole property the valuation is $31,400,000.

PEWABIC LODE.

This is an Amygdaloid at present worked only by the Quincy mine. It is not a single vein but a series of amygdaloid flows carrying copper for a thickness of about two hundred feet. The main lode which contains most of the workings is near the center of this series but perhaps inclines to be nearer the foot wall side. The production of the Quincy Mine up to the end of 1910, was 458,000,000 pounds of copper. This is exclusive of the production of the old Franklin Mine, whose property is now embraced by the Quincy. I have not been able to verify the production of the Franklin, but it was apparently some one hundred and fifty million pounds. The total output of the lode to date may be estimated at about six hundred million pounds.

The vital point in the present situation is that the property has been exhausted to a great depth, approximately 5,200 feet along the slope. It has long been recognized to be in a dangerous condition on account of possible caving. A few years ago the Atlantic Mine suddenly closed up and was permanently abandoned by the operating company. The yield of copper per ton for the last five million tons mined has been less than one-half the yield of the first five million tons. The mine is well equipped and undoubtedly secures the best results obtainable under the conditions, but it is facing the three adverse factors of great depth, a declining yield and the danger of caving. The total production possible from the lode to a depth of seven thousand feet, which may be taken as the ultimate profitable depth, will not exceed two hundred million pounds. A fair present value is based on one hundred and fifty million pounds to be produced in seven years at a cost of 11.3 cents a pound (which is the average of the past five years) and a profit of 2.7 cents per pound. The total profit expected in seven years is $4,050,000, giving it a present value of $3,250,000.

The Hancock Consolidated Mining Company is projecting some explorations on the Pewabic lode but has not yet reached it. This property is nothing but a prospect and I shall not consider it worth anything.

The Franklin Mine is also exploring for the Pewabic lode, but so far as present appearances go the Quincy owns all the ground which is likely to be profitable.

ISLE ROYALE LODE.

The above described deposits are all northeast of Portage Lake. The only two lodes being worked southwest of Portage Lake with any pretensions to success are the Isle Royale and Baltic. The Isle Royale was discovered in the early days and has been worked without success for fifty years. Its record for the past five years shows a cost of 16.7 cents a pound for 21,902,000 pounds of copper. On this record it might be put down as unprofitable, but there is another side to it. The output has been brought up from 192,000 tons in 1906 to 521,000 tons in 1910. The yield of copper per ton has remained substantially the same and shows an average for five years of 14.6 per ton. The cost in 1910, was only 11.8 cents per pound, which seems warranted by the yield of the rock. This indicates that the mine has some value. It seems reasonable to expect that it will produce 112,000,000 pounds above the 4,000 feet level in sixteen years at a cost of 12 cents a pound. This indicates a total profit of $2,240,000 and present value of $1,450,000.

BALTIC LODE.

This is the last important vein discovered in the country. It was opened up about 1897 although some former unsuccessful work has been done upon it. Four mines are situated upon this lode, viz.: The Superior, Baltic, Tri-Mountain and Champion.

SUPERIOR.

Mr. Hague comments upon the Superior as follows:

"This property is in the prospective stage though a very promising one. One shaft has been put down about fifteen levels. 286,566 tons of ore yielding 5,602,408 pounds of copper has been hoisted from drifting as practically no stoping has been done. This is about 19½ pounds copper per ton. Depth and lateral extent must be obtained before any definite statements can be made as to life or yield. About 1,400 feet laterally on the vein has been opened to date. If the Baltic may be used as a standard for this property the following figures may be used for the tonnage developed: 1,900,000 tons at 19⅕ pounds equals 37,000,000 pounds of copper."

One unfavorable feature about this property is that the outcrop of payable ore is short. On the theory that the depth of an ore shoot has some relation to its length, there is some reason to fear that the mine may not prove extensive. It is, therefore, hazardous to count upon an indefinite extension downward. It seems fair that the probable value of the property should be based on an expected output of seventy-five million pounds, this being twice the amount now opened up. Since the property is not equipped, it is probable that 2 cents a pound, or a total of fifteen hundred thousand dollars should be allowed. Therefore, the total expected cost may be put at twelve cents per pound, leaving an average profit of 2 cents a pound, or fifteen hundred thousand dollars to be obtained in fifteen years. This would give the property a present value of about one million dollars.

COPPER RANGE CONSOLIDATED.

This company owns the Baltic, Tri-Mountain and Champion mines. Each of these works upon a separate ore shoot which together cover a length of more than three miles along the vein. Taking these three ore bodies in the aggregate the length is such that one would be disposed to concede the probability of the ore extending to a great depth. However, the ore shoots are separated by large stretches of entirely barren ground. The ore shoot of the Tri-Mountain, which is the central one of the three, weakened abruptly at a depth of about seven hundred feet and the mine has become practically unpayable. I quote the following notes taken after an inspection of the bottom levels of the Champion and Baltic Mines:

"Champion Copper Company.—Present ore shoot is bottomed at B shaft at about 11th level. At E shaft it goes down to 18th level and there plays out. No assurance of any further ore in depth."

"Baltic Mine.—Present ore shoot is bottomed on South end of mine as far North as No. 3 shaft at 22nd level. No. 4 shaft still has ore in bottom but gives signs of weakening. No assurance of any further ore in depth."

The management, however, is not disposed to take these unfavorable developments seriously but fully expects to find better ore at greater depth in all three mines. Under these circumstances I do not feel disposed to express an opinion as to the future of these properties, except that the continuity is not so well demonstrated as in the case of mines north of Portage Lake. There are undoubtedly large gaps of barren territory in the vein separating the richer ore bodies both laterally and vertically.

It is to be remembered that these mines are well managed and have been very profitable, so that a considerable falling off in yield can be withstood before the profits will be extinguished.

BALTIC MINE.

Mr. Hague estimates ore reserves at 3,400,000 tons reasonably assured at twenty-two pounds per ton making seventy-five million pounds copper. If we assume that this is reasonably certain to be extended to five million tons and one hundred and ten million pounds of copper, we get an assured life of about seven years. The cost of production is less than nine cents a pound, profits five cents a pound. This gives an expected profit in seven years of $5,500,000. It is perhaps reasonable to expect that further discoveries will enable the company to make additional profits, which will be sufficient to pay interest on a full valuation of this property after the seven years have expired. It seems, therefore, fair to give the mine a full valuation of $5,000,000.

TRI-MOUNTAIN MINE.

This mine has been able to maintain a cost per pound copper at about 12.8 cents for the past five years, but with a diminishing output both of tonnage and copper. The future of the mine is entirely prospective except for about sixteen million pounds of copper which may be obtained in the next four years at a profit of $192,000. The present value is $165,000.

CHAMPION MINE.

Mr. Hague's estimates of ore reasonably assured on this property is five million tons, which will produce one hundred and ten million pounds of copper. The same assumptions can be made for the Baltic as regards cost and the valuation can be placed at the same figure, viz.; $5,000,000.

LAKE MINE.

Another property situated some twenty miles southwest of the Copper Range group is generally supposed to be valuable. This is the Lake property. It is not by any means assured that this mine will ever pay a dividend. 14,485 tons of rock were shipped from this mine and stamped with a yield of 318,050 pounds of copper, this being an average of 21.95 pounds per ton. If a large tonnage of ore of this grade could be secured and mined at average cost, this property would unquestionably be valuable. But it is stated by the management that the ore shipped to the mills was selected and cannot be taken as a fair average of the mine. At present all effort is being directed toward equiping and opening the mine on a sufficient scale to place mining on an economical basis. Ore will then be sent to one of the Copper Range mills. The cost of freight will be from fifteen to twenty cents per ton. It is not probable that under these circumstances, operating costs will be less than $2.10 per ton. This will make fifteen pounds per ton the smallest yield that can possibly meet expenses. It is hoped that this mine will prove to be something like the Baltic, in which case about two million tons may be conceded to be opened up, which might yield about forty million pounds of copper. Conceding that this product may be obtained at a profit of one cent a pound during the next ten years, we get a present value of about $300,000 for this property.

VALUATIONS OF THE COPPER MINES:

Mohawk	$3,500,000
Ahmeek	7,200,000
Allouez	1,500,000
Wolverine	3,700,000
Osceola Consolidated	6,000,000
Calumet & Hecla	31,400,000
Quincy	3,250,000
Isle Royale	1,450,000
Superior	1,000,000
Baltic	5,000,000
Tri-Mountain	165,000
Champion	5,000,000
Lake	300,000
Atlantic	350,000
Total	$69,815,000

UNPROFITABLE COPPER MINES.

Several companies have mined copper at a loss even during the high prices of the last five years. This fact was ascertained early in the investigation, and unless the record showed some signs of progressive improvement no particular attention was paid to these concerns.

Franklin Conglomerate. The Franklin Junior mine has been working a conglomerate lode between Hancock and Calumet. During the past five years it produced 15,258,000 pounds of copper at an average cost of 16.7 cents per pound. The output declined from 4,571,000 pounds in 1906 to 966,000 pounds in 1910. This record is such that the mine can be classed as absolutely unprofitable and I appraise it at zero.

Atlantic Mining Company makes the following report: "The Atlantic Mine caved in May 26, 1906, and the work done since has been entirely of an exploratory nature except that the stamp mill has been doing some custom work, and this work shows no profits. It was done to keep the mill in condition to use if anything of value was found on ore lands. Explorations are now all stopped and the machinery is being dismantled.

This mine was formerly profitable but suddenly caved in as above described because the openings had become too extensive. This property has recently been absorbed by the Copper Range Consolidated. The consideration was an issue of ten thousand shares of stock of the latter company equal to 2½% of its capital. As the Copper Range Consolidated owns the Baltic and Tri-Mountain mines and half the Champion mine, together with the Copper Range Railroad, it is plain that the valuation to be put on the Atlantic is 2½% of the total valuation of the Copper Range Consolidated. As this includes appraisement of the railroad company, I cannot state exactly what the amount should be, but based upon the valuation I have put upon the above mentioned mines, it should apparently be about three hundred and fifty thousand dollars. This valuation covers 962 acres of mineral land and a mine which is stated to be as good at the bottom as it ever was, but needs to be reopened from the surface.

The Winona Copper Company produced during 1906, 278,182 pounds of copper at a cost of $1.05 per pound; in 1907, 219,332 pounds of copper at a cost of 32 cents per pound; in 1908, 39,310 pounds of copper at a cost of more than five dollars a pound. It has been developed by two shafts; No. 3—1,272 feet deep and No. 4—1,460 feet deep. The rock mined during the last year of production, 1907, produced 12.6 pounds of copper per ton. This record shows the mine to be absolutely unprofitable.

The King Philip Copper Company has spent during the past five years $909,840; is developed by two shafts; 1—1,124 feet deep, and 2—1,324 feet deep. The latter showed ground like that opened in the Winona mine. This mine evidently has no value, the only hope being a remote one of finding better rock. The large amount of exploration done on the Winona and King Philip would ordinarily be considered a sufficient demonstration of the possibilities.

The Ash Bed Mining Company attempted a little mining in 1906 and 1907, producing in 1907—1,600 pounds of copper at a total cost for the period under review of more than eight dollars a pound. In 1907 mining operations were discontinued and have not since been renewed.

The Tamarack Mining Company, which formerly paid large dividends, has become distinctly unprofitable during the period under review. It is still producing considerable copper, having produced 58,314,000 pounds during the last five years. Its average cost has been 15.2 cents per pound. In 1906 the cost was 15.29 cents; in 1907, 16.98 cents; in 1908, 15.53 cents; in 1909, 14.1 cents; in 1910, 14.53 cents.

Undoubtedly the management hopes to reduce the cost and make some profit, but I am not willing to appraise hopes when contradicted by the figures on such scale as this. I, therefore, value the mine at zero.

The La Salle Copper Company produced 791,000 tons copper during 1909 and 1910, at a total cost of 35¼ cents a pound. Thus property has a large acreage on the Kearsarge, Osceola and Calumet conglomerate lodes. The southern end has no promise. Nos. 1 and 2 shafts are down 2,000 feet and 1,400 feet respectively; about 17,000 feet of drifting has been done and out of 181,075 tons hoisted, 64,598 tons were treated as ore, yielding 10.8 pounds of copper per ton. If this record demonstrated anything, it demonstrates that the property is hopelessly unprofitable and I appraise it at zero.

The Gratiot Copper Company produced in 1910, 29,869 tons of rock which were stamped, yielding 283,615 pounds, this being a recovery of 9.5 pounds per ton. Operations were suspended April 1, 1911 apparently with very good reason, and I appraise this property at zero.

The Centennial Copper Mining Company occupies 640 acres of land at the south end of the Kearsarge lode. It adjoins the South Kearsarge and Wolverine mines on the west and it would be strange if none of the ore worked by those companies cross the line. However, the record of this company shows no promise. 10,980,000 pounds of copper has been produced during the last five years at a cost of 18.4 cents a pound, the total loss in five years being about two hundred and ninety thousand dollars. While admitting that this mine may become profitable, this event depends entirely on the extent to which the Wolverine ore body may cross over upon its ground. It is not by any means impossible that it may never do this as some of the ore shoots take a course almost north, in which case the Wolverine ore body might continue in a direction parallel to the Centennial boundary. I, therefore, appraise the value of this mine at zero.

The Victoria Copper Mining Company has produced in the last five years 5,270,000 pounds of copper at a cost of nineteen cents per pound; the average yield is 10.9 pounds per ton. This record shows the mine to be hopelessly unprofitable.

The Mass Consolidated Mining Company has produced during the past five years 10,988,000 pounds of copper at an average cost of 18.3 cents per pound. This mine has been securing about the same results for the last twelve years and has called assessments for the amount of $2,100,000. Its record shows it to be hopelessly unprofitable and I appraise it at zero.

The Michigan Copper Company has produced during the five years under review, 10,561,000 pounds of copper at an average cost of 20.7 cents per pound. Mining operations were suspended in 1910, having continued for some twelve years. They cannot be considered as anything more than an experiment on a grand scale, which proved the property to be hopelessly unprofitable. This company undertook to reopen the old Minnesota mine, which was closed down some thirty or forty years ago after paying more than $1,700,000 in dividends. The mine, at that time, was given up as worked out. It was supposed that improvements in methods and facilities would make the veins payable again. This belief has cost the stockholders of the Michigan more than two million dollars.

I give the above details of these various properties to show at a glance the conclusive character of the evidence in regard to nearly all of them. To attempt to place a valuation upon properties which have no better record than most of those mentioned would be only a joke. In most cases these operations are simply costly experiments more or less completed, undertaken in the hope of developing a profitable mine. When the experiments are carried along beyond the period when the demonstration is thorough, the continuance is a psychological phenomenon.

NON-PRODUCING COPPER COMPANIES.

You will find in the data submitted with this a long list of copper mining companies which have not produced during the five years I have reviewed. Some of them have produced in the past but have closed down permanently; others have produced nothing at all. I have sought for some logical means for placing an acreage value on the undeveloped or demonstrated lands situated upon the copper bearing rocks but without success.

It may be taken for granted that the long list of unprofitable enterprises mentioned above were undertaken upon the best showings of copper that could be found outside of the tracts owned by the profitable mines.

It seems ridiculous to place a valuation upon lands which have no showing at all when costly operations upon lands that have considerable showings of copper have not proved those showings to have any value, but, on the contrary, in most cases have proved them *not* to have any value. The fact is that the copper district has been pretty thoroughly explored. The only surely valuable deposits discovered in the last thirty years were those on the Baltic lode. The discovery of these mines together with a theory that the mining business could be put on an improved basis through the installation of larger plants designed to handle a larger tonnage caused a boom in the district, which lasted pretty continuously from 1898 to 1907. The hopes entertained during this period inspired the expenditures of vast sums of money for explorations, the result of which has been meagre. It is probable that the people of the district have not fully recovered from the speculative mania which lasted so long. Many owners of mineral rights undoubtedly hope to dispose of them for fancy prices. This is largely because in the past promoters have been able to float mining companies and sell their shares to the public. They have actually preferred in many cases to pay owners large sums in cash for their lands rather than to issue stock for them. This kind of a market has no reference whatever to the intrinsic value of the properties.

I take the ground that the State of Michigan does not wish to recognize extrinsic valuations created by promoters whose business is not to produce copper but to gauge the public appetite for speculation.

MINERAL RIGHTS OWNED BY HOLDING COMPANIES.

The St. Mary's Mineral Land Company owns all the stock of the St. Mary's Canal Company and half the stock of the Champion Copper Company. The St. Mary's Canal Company owns about 86,000 acres of land in fee simple and 14,000 acres of land the surface of which has been sold but the mineral rights reserved. Such companies are rarely popular. It is very easy to create in the minds of the people the suspicion that such companies are holding large tracts of land for high prices and thereby impeding proper development and, in a word, living on the "unearned increment." In the case of the St. Mary's Mineral Land Company this suspicion is hardly justified by the facts.

A careful inspection of the record of this concern shows that during the past four years it has earned nothing applicable to dividends except a portion of its dividends from the Champion Copper Company which, of course, is appraised separately. Its total receipts from sources other than the Champion Copper Company dividends are as follows:

Land sales	$227,398	50
For wood and timber	27,253	64
Notes	66,000	00
Ground rent	9,330	39
Interest and sundries	59,785	49
Total	$389,768	02

But its expenditures in the attempt to open up new mines have been very large.

Following are the assessments paid during these years on shares in copper companies:

King Philip Company	$672,714 00
Winona Company	6,736 00
Hancock Consolidated	160,000 00
Ojibway	4,000 00
Houghton Copper Company	55,555 00
Challenge Company	138,000 00
Office	50,792 66
Taxes	86,921 80
Franklin District	2,220 00
	$1,176,939 46

This statement proves that the company has lost $787,171.44, excluding The Champion dividends. This statement rather effectively disposes of the argument that this company is a "dead weight" on the community and is living on "unearned increment."

VALUE OF IRON ORE.

Unlike copper no specific figure can be given for the value of iron. The price of the ore varies according to its chemical and physical qualities. The expected future price of ore has been fixed for the purposes of this report on a calculated value for all grades based on the average quotations for standard ores for the past seven years. As a matter of fact the average for seven years differs very little from the average of the past five years.

These standard prices are fixed annually by the Lake Superior Iron Ore Association. The methods of figuring the price of ore from analysis is fully described in the hand book by Crowell & Murray, of Cleveland, (The Penton Publishing Company, of Cleveland, publishers). It is also explained in Rukard Hurd's Iron Ore Manual of the Lake Superior district (F. M. Catlin, Sales Agent, St. Paul, Minnesota). On account of the rather complicated nature of these calculations they are not described in this summary, but the average price received and the average price expected for the ore of each mine may be found in the tables of figures. The question arises whether the average price for the past seven years is a fair one for the future. As in the case of copper, the prices ruling for the season of 1911 are lower than the calculated average used. The considerations that impel me to use this average are precisely the same as those used in the case of copper, there being the same reasons to expect a continuance of the demand in the one case as in the other. The growth of the iron mining industry in Lake Superior shows some startling figures. The demand has been doubling every ten years. The shipments in 1910 from the whole region were 43,350,715 tons; in 1900 they were only 20,593,570 tons; in 1890—9,003,801 tons and in 1880—1,908,754 tons. While the shipments of one year occasionally fall behind those of the preceding year, it seems to me that no one can expect this prolonged and rapid growth to come to a sudden stop. To be sure the resources of the region are sufficient to maintain an output of forty million tons a year for forty years taking only ore that is merchantable under present conditions so that at recurrent intervals the market may be glutted. But if the demand continues to increase in anything like the proportion that has ruled during the last thirty years, these known reserves will be exhausted in a much shorter time. At least three quarters of all these reserves have been put in sight by the exploration of the Mesabi Range in Minnesota during the last twenty years. The discovery of new ore in that district has almost ceased, and it is to be expected that from now on the already known ore bodies will be in a progressively firmer commercial position. It is conservative to say the amount of new ore discovered in the Lake Superior region each year is not now more than keeping pace with the depletion of reserves. It is also probable that the progress of discovery is now proportionately more rapid in Michigan than in Minnesota.

Michigan has lost to Minnesota her former commanding position in the iron ore trade. In 1880 Michigan produced all of the iron ore shipped from Lake Superior; in 1890 it shipped more than 90%; in1900 approximately 50%; in 1910 less than 30%. In spite of this proportionate loss, the tonnage shipped by the Michigan mines has steadily increased and may be expected to increase.

POSSIBLE EFFECT OF FOREIGN COMPETITION.

For the first time in many years, some of the Lake Superior iron producers are expressing uneasiness as to the effect of competition of iron ores from Cuba and Brazil, especially in view of the probable abolition of the tariff on iron ore. In Cuba there has been developed a reserve of iron ore amounting to three thousand million tons, all lying close to tide water. The ore presents some disadvantages; being very high in moisture, so that while the dried ore runs something over 50% in metallic iron in its natural state, it contains less than *35%*. This fact presents some Metallurgical difficulties which cost money to overcome. At present the ore is put through a process of "nodulizing" before shipment at a cost of *one dollar* a ton. The cost of mining and shipping to the coast is expected to be very small, the ore being really nothing but a ferruginous clay, forming a bed from ten to eighty feet thick on the surface of the ground, requiring no stripping or any preliminary work except to clear away the brush. It is said that this ore can be utilized without the "nodulizing" process, in which case it could probably be delivered at New York or Philadelphia at a cost of $1.25 a ton. At present, however, the nodulized ore must cost well over $2.25 a ton at our Atlantic ports.

Brazil also has a tremendous field of high-grade Bessemer iron ores, running 65 to 68% metallic iron. The field is, however, entirely undeveloped. It is situated three hundred miles inland from the ports of Rio Janeiro and Victoria and is reached by a railroad, but the railroad is such a poor one that it cannot be seriously used as a vehicle for bringing the ores to market. It appears that these ores might some time be delivered in Europe or the United States for a cost of about three dollars a ton. Lake Superior ores of the same grade would cost over five dollars a ton at Lake Erie ports and over seven dollars a ton on the sea board.

I am satisfied, however, that competition from these fields can do nothing more than to curtail the rate of *expansion* of demand for the Lake Superior ores. It will not prevent shipments from continuing at the present rate or even from greatly increasing. I base this opinion on a very simple fact, viz.: that the costs mentioned for Cuban and Brazilian ores are not given upon the same basis as those for Lake Superior ores. In the case of Cuba and Brazil the costs talked of are the bare operating costs, without any allowance for taxes, royalties or profits. A nodulized Cuban ore at the sea board should be compared with a Lake Superior ore of the same grade at Cleveland on the same basis of cost. Admitting that 52% Cuban ore costs without taxes, royalties or profits, $2.25 a ton on the Atlantic coast let us see what the Lake Superior ore will cost on the same basis.

The United States Steel Corporation could deliver its average Mesabi ore at Cleveland for $1.50 a ton.

From its best mines it could deliver such an ore for $1.10 a ton. It could deliver ores mined underground from the Vermillion Range for less than two dollars a ton.

The whole product of the Gogebic Range in Michigan can be delivered at Cleveland at an absolute cost not exceeding $2.35 a ton, and large tonnages for $2.15 a ton.

A large tonnage can be delivered from the Marquette Range of Michigan for two dollars a ton. Large quantities of ore can be delivered from the Crystal Falls and Iron River districts for $1.75 a ton.

It is evident from these figures that the advantage of the Cuban ores is more apparent than real. No one is going to mine Cuban ores without paying taxes or without expecting profits. There are the further disadvantages of having to secure and invest a large capital to provide facilities for shipping the Cuban ore at all. This disadvantage is very much more pronounced still in the case of Brazil.

I do not argue from these considerations that either Brazilian or Cuban ores will not be used for making steel on our eastern coast, for I think they will, but I am satisfied that their effect on prices will be absolutely nil and that it will be a long time before their competition will be even felt in the region now supplied with iron from the Lake Superior mines. At the most the foreign ores will affect the trade only on the sea-board. There is nothing in sight to challenge the dominance of the Lake mines in the whole interior of North America.

EFFECT OF TAKING OFF THE TARIFF ON MANUFACTURED IRON AND STEEL.

The same reasoning that applies to foreign ores applies to foreign manufactures in iron. They cannot come far inland. One consideration which is often forgotten is that the United States produces annually more iron than England and Germany together. "The tail cannot wag the dog." The gigantic thoroughly organized and established iron industry of the United States cannot be overthrown or even seriously deranged by the surplus of Europe. The only probable effect of taking off the tariff altogether would be to prevent prices from going unduly high in boom times and to divide the markets along the coasts. The iron made from Lake Superior ores will have an undisputed field from the Hudson river to the Rocky Mountains, and from the Ohio and Rio Grande to the Arctic ocean.

I believe these statements can hardly be seriously disputed and I recite them as reasons for my belief that the iron ore market will continue in the future on substantially the same course it has pursued in the past; that the demand is sure to increase, and that prices are more likely to be higher than they are to be lower than the average of the past seven years.

QUESTION OF ROYALTIES.

A large proportion of the iron ores are produced from leases, which usually have long terms, so that they might properly be called leaseholds. A majority of the operating companies pay royalties to fee owners and these royalties are to those operating companies a genuine and unavoidable expense. It is probably a uniform custom to make the holder of a lease responsible for all taxes on the lands he leases. It seems hardly fair in view of these facts to assess the operating companies on the royalties which they pay, because from their point of view the royalty is an expense and not a profit. But in answering the plain question which your Board asks, viz.: "what are these properties worth?" I cannot do otherwise than to consider royalties paid as net profits.

The amounts of these royalties are in every case tabulated, together with the ownerships of the fees to which these royalties belong.

TAXES.

You will find in the various tabulations of costs and values that taxes are treated wherever reported as a separate expense and that the proportion of these taxes to operating profits is given. In making appraisals I have allowed each company under the head of General Expense as a portion of the mining cost the average amount of taxes they have paid per ton during the past five years.

TABULATION OF COSTS.

The iron mines of Michigan are usually described as occurring in three "Ranges"—the Gogebic, Marquette and Menominee, but for the purpose of showing the facts in the most intelligible manner, they have been divided into groups, different from the usual classification. Our groupings are determined essentially upon a basis of comparative uniformity of geological occurrence, which necessarily determines the economic factors of cost and value as follows:

District No. 1—The entire Gogebic Range in Michigan, Gogebic county;
District No. 2—Iron River district, Iron county.
District No. 3—Crystal Falls district, Iron county;
District No. 4—Old Menominee district, Dickinson county;
District No. 5—Western Marquette range, Baraga county.
District No. 6—Marquette Hard Ore Mines, Marquette county;
District No. 7—Marquette Soft Ore Mines, Marquette county;
District No. 8—Swanzy district, Marquette county.
District No. 9—Various scattered low grade silicious mines, which produce ores under exceptional circumstances and which have a limited market.

The results are presented in a separate tabulation for each of these districts. These tabulations show for the last five years—the total expenditures, the production and receipts from ore, the ore reserves reported, the total ore reserve counted on the calculation of the average value of ore from the grades reported in the ore reserves, the expected cost for the future based on a study of costs ruling in the past, and a valuation of each mine indicated by all the facts.

It is well to explain that the cost statements will show some inevitable differences in detail. Until all the mines keep their books in exactly the same way this is to be expected; but on the whole the variations are not very great. They mainly arise from the fact that one company may charge its expenditures for certain kinds of construction directly to mining, while another company might put such expenditures into a separate account, calling it "Construction." In the same way, there are certain variations in amounts charged to General Expense, explorations, etc. The student of mining costs will have no difficulty in seeing what the statements mean in each case.

EXPLORATIONS.

This title in the cost statements usually refers to a general campaign of search for ore by some of the larger companies. This work may or may not be on lands owned by the company. It is a practice to take options on likely pieces of land and spend money for geological research and explorations by drilling or test pitting. I have thought it fair to allow the companies who conduct their business in this manner for the cost per ton of all this work. It is spread uniformly over the tonnage produced by all the mines of such operating companies for the past five years. I assume, also, that this expense will be continued and, consequently, allow the same charge in my estimates for future cost.

GENERAL FACTS BEARING ON THE VALUE OF THE IRON MINES.

In comparison with the copper mines, the situation of the iron mines is distinctly more favorable. Several considerations contribute to this.

First: They are not facing any considerable deterioration in the metallic contents of their ores, nor are they facing the impending exhaustion of any commandingly important property. The probable downward limit of ore occurrence is no where in sight.

Second: The condition of their ore reserves is excellent and this points to a continuance of production, with almost absolute certainty for a period of twenty-five years in advance.

Third: In contrast to the paucity of discoveries in the Copper country, many new deposits have been discovered within recent years, so that in addition to the continuance of the present mines, there is reason to expect that new ones will continue to come in.

Fourth: The actual earnings of all iron properties in the five years under review were $57,400,000. This was earned by 78 mines on sales of 52,590,896 tons of ore. These are net profits over and above all expenditures including the purchase of new equipment, many outside explorations and taxes. The copper mines earned fifty million dollars in the same period, but by far the greater part of this was earned during the years 1906 and 1907 when copper was abnormally high. Calculating on the normal price the earnings would have been only $41,200,000. In the case of iron mines the prices, and consequently, the earnings for the past five years were practically normal.

The actual ore in sight is sufficient to guarantee the production and earnings on the same basis for sixteen years. Without going further than this we can find reason for giving them a valuation of one hundred and fifteen million dollars. But it is practically as certain that the production can be maintained for twenty-five years as that it can continue sixteen years. With such a life the mines would be worth one hundred and fifty million dollars.

I am convinced that they are worth this amount, but, for two good reasons, it will be impossible to apportion the value among the various mines in order to bring them up to this total.

First: Because it is much easier to be sure of the endurance of a whole district than of a circumscribed tract covering a small part of the district.

Second: Important occurrences of ore are sometimes divided in ownerships in such a way as not only to diminish the probable profit to be obtained from them but also to throw doubt as to the proportion belonging to the different owners.

Both these factors are constantly in evidence in all the districts.

VALIDITY OF ESTIMATES OF ORE RESERVES.

Our calculations are based on three elements:

First: Ore found in drill holes. In practically all cases we have been compelled to estimate this ourselves by the very simple method of measuring the area which the drill holes seem to demonstrate to be occupied by a continuous ore body, and multiplying this area in square feet by the average thickness of ore shown in the holes of the group. The number of cubic feet thus calculated gives the tonnage by dividing by the number of cubic feet representing a ton of ore in the district to which the ore body belongs.

There is some latitude for the exercise of judgment in determining the area to be considered as demonstrated, but in no case have we taken areas greater than can be obtained by drawing lines fifty feet outside of holes in ore.

Second: Ore reported by companies as being in sight above bottom levels of their mines.

Third: An additional amount of ore added on my own judgment of what is reasonable for extensions below the bottom levels.

Since all of these calculations are based upon documents submitted by the companies themselves, it is plain that only one element in the estimates on expected tonnage is open to serious dispute, viz.: the extent to which my judgement may be in error in assuming the extensions. Only a portion of this element can be open to question because it is patent that there must be some extensions.

DISTRICT NO. 1. GOGEBIC RANGE.

In this district no ore whatever is indicated by drill holes. We have to consider the following facts: The ore formation consists of a narrow band of ferruginous rock about eight hundred feet thick inclined to the north at an angle of seventy degrees and extending fifteen miles in Michigan from the Montreal river to a point east of Wakefield.

The following table shows the amount of ore shipped by these mines up to the end of 1910 and the amount reported in sight above the bottom levels:

	Tonnage shipped to end of 1910.	Reported in sight.	Total above present bottom levels.
Ashland	5,618,390	197,000	5,815,390
Norrie	25,385,930	9,361,500	34,747,430
Newport	7,027,363	5,475,000	12,502,363
Puritan	159,590	50,000	209,590
Ironton	958,910	130,000	1,088,910
Yale	481,426	0	481,426
Colby	2,645,101	815,800	3,460,901
Tilden	5,188,572	404,500	5,593,072
Anvil and Palms	2,058,686	379,000	2,437,686
Eureka	503,745	65,000	568,745
Asteroid	0	10,000	10,000
Mikado	1,049,800	20,000	1,069,800
Chicago	68,727	184,000	253,727
Brotherton	1,855,124	995,000	1,950,124
Sunday Lake	1,422,461	150,000	1,572,461
Castile	55,444	1,000	56,444
Total	54,479,269	17,338,800	71,818,069

To this figure of 71,817,000 should be added 3,600,000 tons additional for a correction, which I will not take time to explain, giving a total showing of 75,400,000 tons above the average bottom level which is 1,450 feet deep.

Now, we find that on the bottom levels there is exposed in this range a total area of 662,000 square feet of ore avoiding all duplicate sections of any ore body and, since ten cubic feet will make a ton this is equal to 66,000 tons for every additional vertical foot. Working this back toward the surface we find that the depth of 1,450 feet would mean more than ninety million tons instead of the seventy-five million tons accounted for. In other words, the showing of ore on the bottom levels is actually better than the average of the mines during their past history. Furthermore, the deepest of the mines is 2,140 feet deep, being seven hundred feet lower than the average. At this depth the showing of at least one ore body is magnificent and it will surely go much deeper. With these facts in view no intelligent mining man will disagree with the opinion that large additions to the measurable reserves is absolutely called for before any adequate figure for the valuation of the mines can be reached. It is perfectly rational to expect them to produce as much ore in the future as they have in the past. However, I have been cautious in assuming great extensions.

NORRIE MINE.

The property is two miles long. One section at the west end is developed down to the vertical depth of 1,592 feet. Along the central section of the bottom level is approximately 1,200 feet and toward the east end 1,445 feet. We may say that this mine is developed to an average depth of 1,400 feet. Above this level there are reported in sight 9,361,500 tons of ore. One great ore body at the east end of this property is developed to a depth of 1,445 feet. It is known to be the same ore body which has been developed in the neighboring Newport Mines to the east to the additional depth of 388 feet. The area of the Norrie in this body is 182,000 square feet. In the Newport on the 1,940 foot level the area is 306,000 square feet. The average of these two sections is 244,000 square feet. This gives a volume of 9,467,000 tons of ore between these two levels, of which 7,200,000 is accounted for and the remainder 2,271,000 is to be added to the Norrie. This whole amount has to be added to the ore reserves reported being the total of assured ore up to over 11,600,000 tons.

In the central and western portions of the mine there is exposed a total area of 205,000 square feet of ore at the bottom, of which 195,000 square feet is only developed to the 1,200 foot level. The smaller ore body is just entering the property at the extreme west end at a depth of 1,592 feet. If the great Central ore body goes down merely to the depth demonstrated for the smaller Western body it will yield seven millions additional. If it goes down to the depth to which the Eastern ore body is developed on the Newport, 2,140 feet, it will yield an additional sixteen million tons. But for our purposes I only add a modest 6,400,000 tons for the continuation of these bodies bringing up my total estimate for the Norrie to about 18,000,000 tons, which is sufficient to last the mine at the rate of its average sales for the last five years, for seventeen years. It is almost needless to say that this estimate is moderate and undoubtedly below the expectations of the owners.

NEWPORT MINE.

This is the deepest mine not only on the Gogebic Range but in the whole Lake Superior iron region. It is now working principally upon a great body of ore which has descended into it from the Westward through the Norrie property. Above the 2,140 foot level there is reported in sight 5,475,000 tons. To this can be added, with absolute confidence, 3,600,000 tons, merely by assuming that the developments on the 2,140 level will show the ore to be as large on that level as it is on the 1,940 level. This development has already progressed enough to demonstrate it as a practical certainty. This makes our estimate nine million tons assured. The question remains how much ore should be allowed below the 2,140 foot level. An assumed extension of 270 feet additional depth would give us eight million tons. Another assumption based on the possible termination of the ore body against a certain dyke about one thousand feet to the eastward of the center point of the present ore body gives approximately the same estimate, viz.: eight million tons. If we use this we might assume a total of some seventeen million tons for this property. This is entirely reasonable because it is based only on one ore body. The Norrie mine shows two other large ore bodies below the one on which the Newport is working, and both pitching eastward into the Newport property. Absolutely nothing is known about the depth to which this mineralization may extend. I am satisfied that an expected life of twenty years at 800,000 tons a year will not meet with serious dissent on the part of the owners.

OTHER MINES ON THE GOGEBIC.

It will be noticed that the Norrie and Newport together have shipped 60% of the whole output of the District. They are credited with 80% of ore reserves. During the past five years they have made 75% of the profits of the district.

These comparisons are more than reflected in the valuations put on mines, the Newport and Norrie together accounting for approximately 84% of the valuation. I am satisfied that this proportion for the Newport and Norrie is too high and too low for the others. But it is not on the whole unfair to the operating companies because the Norrie Mine is owned by the Oliver Iron Mining Company which also controls the Tilden, Puritan, Geneva, Davis and Chicago properties. These mines cover an important part of the range outside of the great central ore body, but in all cases I have given them either no value at all or merely a nominal value because the ore reserves are small and the costs have been high.

The Newport Mining Company controls, beside its main mine, the Anvil and Palms, on which an exceedingly promising ore body has been found. It will probably prove to have a much higher value than I have given it.

The other mines are given tonnage somewhat in proportion to their past records.

The Colby Mine I am crediting with an expectation of fifteen hundred thousand tons to be mined in ten years. This property has shipped in the past 2,645,000 tons and reports 815,000 in sight, making a total of 3,460,000 tons. The mine gives no indication of being bottomed or worked out, and I have added for extensions of its present ore bodies 20% for ore yet undeveloped. I am satisfied that it will produce more.

The Ironton Mine has shipped 958,000 tons and reports in sight 130,000 tons, giving a total of 1,088,000 tons. It has recently cut an ore body in the north formation, which from its position is probably important. I think it reasonable to assume, therefore, that the mine will develop ore equal to a third of that it can account for at present.

The Mikado Mine has shipped 1,050,000 tons and reports 20,000 in sight. Since this mine shows no indication whatever of playing out, I think it reasonable to assume that it will produce half a million tons more, largely because it is improving in the bottom after passing one or two rather poor levels.

The Brotherton and Sunday Lake Mines together account for more than 3,500,000 tons of ore. They are working on the same ore body which seems to be pitching to the eastward. It shows remarkable continuity and is improving. The bottom level, 1,068 feet deep in each, shows a continuous body of ore 1,700 feet long with an area of excellent ore 61,000 square feet. It is divided about equally between the two properties. This is equal to 6,000 tons per vertical foot. I think it fair to assume that this ore body will produce 2,500,000 at least. On account of the pitch towards the Sunday Lake I give that property three-fifths of this expected tonnage.

For the district as a whole, it will appear from the table that I have seen fit to increase the tonnage reported in sight from 17,400,000 to 42,900,000. Of this increase I consider 11,000,000 tons to be practically demonstrated, bringing the total of demonstrated ore up to 28,400,000. I am assuming 14,500,000 tons more for extensions of the principal ore bodies beyond their present bottom levels. This means an extension of less than three hundred feet in depth and increasing their present depth only 20%.

VALUATION IN DISTRICT NO. 1.

A high average grade and consequent high value of the ore of this district makes the value of its mines higher than the other districts, in spite of the fact that the expected tonnage is less than in some of the others.

The total valuation of the group is $41,560,000 based on an expected future product of 43,000,000 tons and an annual output of about 2,900,000 tons.

DISTRICT NO. 2. IRON RIVER.

Dr. Leith describes this district as follows:

“The ores are in closely folded upper Huronian slates. The iron formation lenses are uniformly steep dipping. In a large way they have a distinct linear trend but almost every property shows major and minor buckles and considerable narrowing or widening of the formation. The walls of the ore body may be all slate, all jasper or any combination of the two. The larger ore bodies occur in places where formation has been thickened by folding. The axes of these folds are favorable places for the concentration of ore. They have steep pitches and should have great persistence in depth. * * * As would be expected under these conditions, individual ore bodies have the greatest iregularity in outline, although looked at in a large way, they may conform to the major trend of the district. The under-ground developments are yet shallow, the deepest mine being 690 feet deep and the average being about 450 feet. Drilling, however, has shown the ore to go down to a depth of 1,712 feet.”

The active mines show the following record to the end of 1910:

	Tons shipped.	Tons in sight above bottom.	Total.
Osana (James)	231,359	520,000	751,359
Chatham	181,427	43,000	224,427
Hiawatha	614,496	254,993	869,489
Baker	84,420	....	84,420
Dober	2,195,146	372,259	2,567,405
Baltic	1,340,593	713,000	2,053,593
Fogarty	168,936	460,000	628,936
Caspian	699,305	3,505,500	4,204,805
Youngs	473,784	250,000	723,784
Zimmerman	37,690	1,000,000	1,037,690
Berkshire	135,734	563,000	698,734
Total	6,162,890	7,681,752	13,844,642

The exposure of ore in the bottom levels of these mines is approximately 1,100,000 square feet. Drilling in this district shows ore in one hole at 1,712 feet from the surface and in several others at a depth of more than 1,500 feet. If we imagine that the ore shown in these mines will approximate an inverted pyramid the point of which is 1,500 feet below the present bottom, we get a tonnage from these exposures alone of more than 45,000,000.

A rough estimate of additional ore shown by drilling is as follows:

Davidson ore	2,000,000 tons.
Rogers mine	2,500,000 tons.
N. Y. State Steel	2,000,000 tons.
Michaels	1,000,000 tons.
Tully	3,500,000 tons.
Donahue	800,000 tons.
McGovern	350,000 tons.
Bates	400,000 tons.
Wickwire	41,000 tons.
Erickson	732,000 tons.
Total	13,323,000 tons.

In summary we get the following:

Expectation of continuations from bottom levels	45,000,000 tons.
Shown by drilling	13,000,000 tons.
Ore reported in sight in active mines	7,500,000 tons.

We get here a total of approximately 65,000,000 tons as a reasonable estimate. I have no doubt this will be greatly exceeded for the area of ore in sight in these mines is two and one-half times as great as was the average of the old Menominee Range which has accounted for 50,000,000; five times as great as the Crystal Falls district which has accounted for 20,000,000 tons and one and one-half times as great as the Gogebic Range, which accounts for 75,000,000 tons. All these comparisons would lead one to believe that this district would produce 110,000,000 tons by the time it reaches the state of development in which the other districts now are. It contains one of the greatest ore reserves in Michigan, if not quite the largest.

DAVIDSON MINE.

This property is still in the developing stage, having shipped no ore. It reports 2,000,000 tons in sight which is a reasonable estimate.

OSANA MINE.

This property has a tremendous showing on its bottom level, no less than 159,000 square feet of ore being exposed at a depth of 300 feet below the rock surface. The ore body is apparently irregular for the third level shows a cross section of only 20,625 square feet. I have no hesitation in raising the tonnage to be expected from this mine to 2,000,000 tons.

WAUSECA MINE.

This property has shipped no ore but shows two levels each with a cross section of approximately 30,000 square feet. The lowest levels are the bottom level being 400 feet deep. The company reports 40,000 tons in sight but I have no hesitation in increasing this amount to half a million and adding another half million for good measure, which will bring the total expectation up to 1,000,000 tons.

NANAIMO MINE.

This property is described as exhausted.

CHATHAM MINE.

This property reports 43,000 tons in sight with an exposure in bottom level of 6,000 square feet. I count on it for 100,000 tons.

HIAWATHA MINE.

Reports 254,993 tons in sight with an exposure of 32,000 square feet on the bottom level. It accounts for nearly 900,000 tons with a depth of 575 feet below the rock surface. Apparently the mine is as good as ever and a million tons is a reasonable estimate for its future.

CHICAGO MINE.

This company has shipped no ore but reports 390,305 tons in sight above the bottom level which is 500 feet deep, and shows an area of 13,000 square feet of ore. 600,000 tons is a reasonable estimate for this mine.

TULLY AND BAKER.

The Baker is a small property which contains an ore body that has worked across the line of the neighboring Tully Mine to the westward. The Tully shows three important ore bodies by drilling. A conservative estimate of these shows up 3,500,000 tons. Nothing was reported in sight.

MICHAEL'S AND BLAIR'S EXPLORATIONS.

On the Michael property ore is shown up in drilling at a depth of 1,712 feet. Five holes show an average depth of 210 feet in ore. There is, at least, 1,000,000 tons indicated here, but on account of its depth it will not be available for a long time.

MCGILLIS, DOBER AND ISABELLA MINES.

These properties are all owned by the Oliver Iron Mining Company and account for 2,500,000 tons above a depth of 690 feet. The total area of ore exposed at the bottom of these mines is 47,600 square feet, enough to make 4,000 tons per vertical foot. It seems safe to add 40% of the total ore accounted for for future expectations which will be equal to 1,000,000 tons in addition to 372,000 tons reported in sight making about 1,400,000 tons.

BALTIC AND FOGARTY MINES.

These mines are operated together. The Baltic accounts for 2,050,000 tons of ore above the 450 level. This means about 4,500 tons per vertical foot which is accounted for by an average cross-section of 54,000 square feet. The lowest developed level shows an area of 74,000 square feet, enough to make more than 6,000 tons per vertical foot. It is perfectly safe to add 1,000,000 tons for additional ore in this property, making a total expectation of 1,700,000 tons. The Fogarty is only 265 feet deep, of which a considerable part is occupied by surface gravel. At this depth it accounts for a total of 630,000 tons, of which 460,000 tons are in sight. Its bottom level shows an area of 74,800 feet. There is every reason to expect that this mine will prove as productive as the Baltic which will enable us to add 2,500,000 tons as a reasonable extension, giving it nearly 3,000,000 tons for the future.

CASPIAN MINE.

The Caspian Mine accounts for 4,200,000 tons above the bottom level which is 290 feet deep, the sand being probably more than 100 feet on the average. This mine has one of the largest ore bodies in the whole Lake Superior region, showing on its bottom level a cross section of 377,000 square feet, or about 8 and one-half acres between vertical walls. This is sufficient to make more than 30,000 tons for each vertical foot. The ore is actually known to occur 100 feet deeper than the present bottom and immediately north and in its trend drill holes show great quantities of ore at more than 1,300 feet deep. I have not the slightest hesitation in counting on this mine for 10,000,000 tons of ore, which is sufficient to maintain an output of 400,000 tons a year for 25 years.

HOULIHAN MINE.

This property is north of the Caspian. One partially developed level immediately under the sand shows a cross-section of 167,000 square feet. It may prove to be as large as the Caspian but I give it a tonnage of only 5,000,000 tons, this being sufficient to maintain an output of 250,000 tons a year for 20 years.

YOUNGS MINE.

This property reports a total of 725,000 tons of ore, of which 250,000 tons are in sight above the 418 foot level. Part of the ore is pitching northward onto the neighboring Fogarty mine. It shows an area in the bottom of 42,000 square feet, enough to make 3,500 tons per vertical foot. A reasonable extension for such an ore body would be 750,000 tons, bringing the total expectation up to 1,000,000 for the future.

ZIMMERMAN MINE.

This property shows on one fully developed level an area of 50,000 square feet of ore. Ore is shown in a drill hole 200 feet below this level. The company counts on 1,000,000 tons, which is a very reasonable estimate.

BERKSHIRE MINE.

This property accounts for about 700,000 tons above the bottom level which is about 300 feet below the rock surface. It reports 563,000 tons in sight and on its lowest developed level shows a cross-section of 25,500 square feet. 1,000,000 tons is a reasonable expectation for the future of this mine.

ROGERS MINE.

This property is still in the development stage, but shows up a very large amount of ore by drilling. I estimate the mine at 2,500,000 tons, but it is not all merchantable, some of it being mixed with manganese.

The total amount of ore apportioned among the Iron River mines is only 42,000,000 tons which I believe, as explained above, is far less than may reasonably be expected. Nevertheless, it is sufficient to maintain the average tonnage of the past five years for fifty years and gives these mines all the present values that can be charged against them at present with propriety. An extension of life beyond fifty years has little or no present value. The demand for ores in this district is moderate, although it will probably increase rapidly from now on. At present the biggest mines in the district are shut down. On account of the patent fact that almost every mine in the district has enough ore to keep up its output at the rate at which it can be marketed for 15 or 20 years, I have not thought it worth while to make any effort to estimate the ore with any great care.

DISTRICT NO. 3. CRYSTAL FALLS.

Dr. Leith has the following to say about this district:

"The ores are in upper Huronian slates, except for the Mansfield, which is in a band of slates in the Hemlock volcanics, and the Groveland which lies at the base of the upper Huronian series in the Felch schist. As in the Iron River district, the iron formation lenses are steeply tilted, much folded and show great variations in thickness. The walls may be slate or jasper or any combination of the two. The larger ore bodies occur in folds in the iron formation, which have thickened the iron formation. The pitch of these folds has considerable persistence in depth. There are few forties containing iron formation where some ore has not been found."

He also says, "in addition to the ore shown in mines, there are 467,000 square feet of ore shown by drilling, which by conservative estimate indicates 1,412,000 tons."

The active mines of the district show the following record to the end of 1910:

	Tons shipped.	Tons in sight above bottom.	Total.
Hollister	96,416		96,416
Crystal Falls	1,735,251	42,000	1,777,251
McDonald	7,166	10,000	17,166
Bristol	2,456,100	522,000	2,978,100
Armenia	377,081	50,300	427,381
Great Western	1,952,937	97,300	2,050,237
Tobin	1,630,549	135,300	1,765,849
Dunn	1,658,015	67,000	1,725,015
Michigan	171,719	78,000	249,719
Hemlock	1,705,226	125,000	1,830,226
Mansfield	1,217,355	32,000	1,249,355
Total	13,007,815	1,158,900	14,166,715

These mines are estimated by Dr. Leith to have an average depth of 1,023 feet, weighted according to the tonnage extracted. When we come to compare the bottom areas with the ore extracted to this depth, allowing 12 cubic feet to the ton of ore, we find that the present bottom area exceeds that of the average area in the past by nearly 30 per cent, the total tonnage accounted for being 14,000,000 tons, which means that about 14,000 tons has been the average per vertical foot, which would give an average horizontal cross-section of 168,000 square feet. The actual cross-section at the bottoms is 207,250 square feet. This showing is exceedingly favorable. It is probably safe to add for future discovery an amount equal to 50% of what has been accounted for to date.

HOLLISTER MINE.

This is an unprofitable mine with an insignificant showing. I make no estimate for it. The same thing may be said of the McDonald.

MANSFIELD MINE.

The Mansfield mine is 1,200 feet deep. That depth accounts for 1,250,000 tons, which means 10,400 tons per vertical foot and a cross-section of 12,500 square feet for the average. The deposit is diminishing in size so slowly that there is little danger in assuming that its probable extension will amount to about 500,000 tons. This is equal to a product of 75,000 tons a year for seven years.

BRISTOL MINE.

This property at a depth of 960 feet accounts for close to 3,000,000 tons, which is equivalent to 3,200 tons per vertical foot, indicating an average cross-section of 38,000 square feet. This is now diminished at the bottom to 26,000, indicating a diminution of 2,500 square feet for each 100 feet additional depth. This indicates that the mine would be bottomed at a depth of 2,000 feet and that the additional tonnage expected might be estimated at about 1,000,000 tons. This in addition to 522,000 tons reported in sight, gives an expectation of approximately one and one-half million tons. This is sufficient to maintain an output of 250,000 tons for six years.

ARMENIA MINE.

The bottom level is 566 feet deep and the total accounted for is 427,000 tons. This indicates an average of less than 800 tons per vertical foot, which would be provided for by ore bodies having an average cross section of less than 10,000 square feet. At the bottom the mine shows an area of 20,500 square feet in ore. It is perfectly safe to count on this mine for half a million tons additional ore. This, with the amount reported in sight, is sufficient to maintain a tonnage of 55,000 tons for ten years.

GREAT WESTERN.

This property has on the 1,157 foot level an area of 33,000 square feet. Above this it accounts for a total of 2,050,000 tons, indicating an average of almost 2,000 tons per vertical foot, which would be provided by ore bodies having an average cross-section of 24,000 square feet. The area of the bottom level is 33,000 square feet, enough to produce 2,750 tons per vertical foot. Ore has actually been reached at the 1,267 foot level. The condition of the property is apparently excellent, and I have no hesitation in adding an expectation of 700,000 tons to the amount reported. This will give 800,000 tons, or enough to maintain an output of 100,000 tons a year for eight years.

TOBIN AND GENESEE.

This mine down to the 1,100 foot level accounts for a tonnage of 1,765,000 tons, equal to 1,500 tons per vertical foot, which would be provided by an average cross-section of ore of 18,000 square feet. The mine shows an area of ore on the bottom level equal to 65,000 square feet, sufficient to make 5,400 tons per vertical foot. This has actually been demonstrated to continue 125 feet deeper, which would enable us to estimate 675,000 tons more. This, with the amount reported in sight, namely, 135,000 tons, gives us 810,000 tons. I have no hesitation in figuring that this mine is not more than half worked out, and, assuming that it will produce as much in the future as accounted for in the past, 1,765,000 tons, which is sufficient to maintain a tonnage of 200,000 tons a year for nearly nine years.

CRYSTAL FALLS MINE.

The Crystal Falls Mine is 1,063 feet deep and has produced and (at that depth) can account for nearly 1,800,000 tons, or approximately 1,700 tons per vertical foot, which requires an average cross-section of 21,000 square feet. The bottom level shows only 17,000 square feet, indicating some weakening, but nothing very serious. It is safe to count on this mine producing half a million tons more, equal to 50,000 tons a year for ten years.

DUNN MINE.

This property is 1,500 feet deep and its ore body has reached the boundary line. I count on it for only about 117,000 tons.

MICHIGAN MINE.

This property accounts for 250,000 tons at a depth of 600 feet. The output would be produced by an ore body having an average cross-section of 5,000 square feet. At the bottom the mine shows an area of 2,880 square feet in ore. It is getting rather small and I do not count on the property producing more than 100,000 tons, which is only 22,000 tons more than is reported in sight.

HEMLOCK MINE.

This property is 935 feet deep and accounts for 1,830,000 tons. Its lowest developed level shows an area of 22,000 square feet, but a still lower level has failed to find the ore. On this account only half a level is allowed below the 935 foot level, giving 55,000 tons to be added to reported estimate of 125,000 tons, or a total of 180,000 tons.

VALUATIONS IN DISTRICT NO. 3.

In all cases I am allowing for increase of mining costs due to increasing depths and the exhaustion of the mines. I am counting on the active mines for an annual product of only 880,000 tons against annual shipments of 1,220,000 tons for the past five years, the expectation being that the falling off in this district will be made up in the Iron River district. Ore found in drill holes is appraised on a basis similar to that of Iron River.

The total valuation of the district is placed at $6,297,000 and an expected tonnage of 8,064,000 tons. This is equivalent to about 75 cents a ton for the expected ore as against only 40 cents for Iron River district. This difference in valuation is caused by the difference in the expected life of the properties.

DISTRICT NO. 4. OLD MENOMINEE RANGE.

The active mines present the following record to the end of 1910:

	Tons shipped.	Tons in sight above bottom.	Total.
Penn Iron Mining Co.	8,845,135	1,437,265	10,282,400
Pewabic	7,317,165	1,233,000	8,550,165
Loretto	1,311,068	1,107,424	2,418,492
Chapin	17,649,477	4,194,679	21,844,156
Aragon	6,077,327	1,085,000	7,162,327
Millie	368,267	20,000	388,267
Total	41,568,439	9,077,368	50,645,807

Dr. Leith has the following to say in regard to the ores of this district:

"The ores are partly in tabular bodies paralled to bedding, and partly in more or less well developed pitching folds bottomed by dolomite, talc-schist or slate and are, therefore, elongated in the direction of the pitch. The degree to which the ore is found to follow these pitches varies in different mines and in different parts of the same mine; in general, the pitches being less well developed near the surface than below. The folds unquestionably pitch a long distance below the present bottom levels and there seems to be no reason geologically in the character of the rock and alterations or other features of the bottom levels, why the ore, at least for shallower mines, should not continue on these pitches to as great a distance below the surface as have been reached by the deepest mines of the district, and probably even greater depths."

Dr. Leith also states, "The total area of ore on fully developed bottom levels of the Menominee district in which the ore is not known to be cut off by rock or pitching off the property within a limited distance, is 263,435 square feet. The average depths of these bottom levels, weighted according to tonnage, which has been shipped from the mine, is 1,160 feet. If the ore shown in bottom levels continues with present areas to the depth of the deepest known ore, this would give 6,320,000 tons as probable ore for the district."

The salient facts which appeal to me are the following: The total amount of ore accounted for above the 1,160 foot level is 50,645,807 tons. This means that the average horizontal area of the ore bodies has been in the past approximately 440,000 square feet. If we assume that this area is normal for the 580 foot level and that for the 1,160 foot level the area is only 263,000 square feet, we get a diminution of approximately 180,000 square feet in 600 feet. This means that each additional 100 feet in depth means a diminution of area of 30,000 square feet. On this basis we might assume that the ore would vanish at a depth of 1,900 feet. This assumption would leave us below the present bottoms approximately 9,000,000 tons.

PENN IRON MINING COMPANY.

This company owns the Cyclops, Norway, East and West Vulcan, Curry and Brier Hill mines, covering a length of three miles along the Menominee Iron Ore formation. It shows at an average depth of 930 feet—71,245 square feet of ore. It accounts for a total of 10,282,000 tons in a vertical producing depth of 900 feet. We may assume that at a depth of 450 feet, the average horizontal area of the ore bodies would have been 115,000 square feet which is diminished at the present bottom to 71,000. This means a diminution for each 100 feet of approximately 10,000 square feet of area and points to a probable tonnage yet to be opened up of 2,400,000 tons. Adding this to 1,437,000 tons in sight would give a probable future tonnage of 3,800,000 tons which is enough to last a mine at its average production for ten years.

As a matter of fact these mines have as much in sight now as they ever had; considerable additions in the last two or three years having been made to the tonnage in sight. Our figures mean that an assumption is made that ore will be found in the future equivalent to 23% of what has been found in the past.

PEWABIC MINE.

This was formerly a very high grade and profitable mine, but it has been bottomed. No estimate whatever is made for continuance.

CHAPIN MINE.

This great property shows at a depth of 1,400 feet an area of ore amounting to 140,000 square feet. Above this level it accounts for 21,844,000 tons. The average cross-section assumed at 700 feet depth was only 160,000 square feet. The diminution in volume with depth, therefore, is slow and the prospects for the future are considerable. The developments on the bottom level, however, are not quite so favorable as they look, and I would assume that the mine will be bottomed at the same increase of depth as in the case of the Penn. This will give us about 4,900,000 tons, or again, about 23% as much as has been discovered in the past. This amount added to what is reported in sight gives 9,000,000 tons for the property, sufficient to maintain an output of 600,000 tons for 15 years.

ARAGON MINE.

This property shows at a depth of 1,100 feet an area of developed ore of 31,000 square feet. It accounts for 7,200,000 tons above this level which means an average section of 65,000 square feet, and a diminution of 6,500 feet for each level. This means that the mine will be bottomed at 500 feet deeper and gives us an additional tonnage of only 750,000 tons. My calculation, therefore, for this mine is that it can produce this amount in addition to 1,085,000 tons reported in sight, in all 1,800,000 tons, sufficient to maintain an output of 180,000 tons for ten years.

LORETTO MINE.

At a depth of 800 feet, this mine shows a cross-section of 21,200 square feet. The average in the past has been over 30,000 square feet. It is losing volume, therefore, at a rate of about 2,250 square feet for each level, which would bottom the mine at a depth of 1,700 feet and justifies an expected extension of tonnage equal to about 900,000 tons. We can, therefore, give this mine a total expectation of 2,000,000 tons and a life of twenty years at 100,000 tons a year.

MILLIE MINE.

This property only shows 20,000 tons in sight and shipments of 368,000 tons in the past. On account of certain developments in the Chapin Mine immediately below it and to the westward, I think it fair to assume that this mine can produce as much ore in the future as it has in the past.

VALUATIONS IN DISTRICT NO. 4.

It will be noted that this is the least promising in Michigan for the future. It has been shipping annually more than 1,860,000 tons. I am counting on a product for the future of only 1,540,000 tons, expecting as in the case of Crystal Falls that the falling off will be made up in Iron River. The total valuation of these mines is $11,391,000 based on an expected tonnage of 18,233,000 tons.

DISTRICT NO. 5. MINES OF THE WESTERN MARQUETTE RANGE IN BARAGA COUNTY.

This district has never been profitable to any considerable extent. It contains only four mines which are spasmodically active, namely, the Imperial, belonging to the Cleveland Cliffs Company, and the Ohio, Portland and Beaufort, belonging to the Niagara Iron Mining Company.

The Imperial reports	1,500,000 tons.
The Ohio reports	117,000 tons.
The Portland reports	247,000 tons.

There is no occasion to add anything to the estimate of the Imperial. Dr. Leith finds reason to add 200,000 tons of probable ore to the Ohio and Beaufort, bringing the total of this district up to 2,064,000 tons.

VALUATIONS IN DISTRICT NO. 5.

The only mine in this group that has any pretentions as to value is the Imperial, which is put down at $335,000.

DISTRICT NO. 6. MARQUETTE HARD ORE MINES.

The record of shipments of the active mines of this district is not easy to obtain because the mining companies report hard ores and soft ores together. The distribution of tonnages for this and district No. 7 is only approximate.

Dr. Leith describes this group as follows:

"The ores at the top of the Negaunee formation just below the Goodrich quartzite are throughout the district hard hematites, locally more or less specular and magnetic. In certain of the mines the basal conglomerate of the upper Huronian which rests against these ores is also sufficiently rich to be mined and constitutes a part of the ore bodies. The ore bodies are tabular in shape parallel to the steep dipping contact of the Negaunee and Goodrich quartzite, though locally folded and faulted. Soft hematite is locally found in these mines in the jasper foot wall. In the Section 16 mine the hematite and hard ore have come together on the bottom level, and the soft ore is becoming relatively more abundant."

"The aggregate area of bottom levels of such of these mines as have not been nearly exhausted is 350,000 square feet. The average depth of producing mines not weighted according to tonnage is 1,041 feet. These ores have been mined to a depth of 1,984 feet at Champion and this group, as a whole, constitutes the deepest of the Marquette mines. The persistence of the ore-bearing horizons to the present levels is taken to promise well for still further persistence in depth."

REPUBLIC.

This property at a depth of 1,900 feet has shipped 6,344,000 tons and reports in sight 1,358,000 tons making a total of 7,800,000 tons. The ore is very dense and seven cubic feet of it, in place, makes a ton. Two ore bodies at or near the bottom show an area of 35,000 square feet, sufficient to make 5,000 tons to the vertical foot, but one of them is weakening. Still, in view of the fact that the showing of ore at the bottom, if projected to the surface, is sufficient to account for the whole tonnage mined to date; the mine may be said to look very well at the bottom and I think it reasonable to add an expectation of 20% of the amount already accounted for for future discovery. This makes a total expected tonnage of 2,900,000 tons.

WASHINGTON AND BARRON.

These properties have had a spasmodic activity for forty years and have not been very profitable. They have produced altogether probably a million tons and report 300,000 tons in sight, which Dr. Leith increased to 432,000 tons.

AMERICAN.

This property also has been worked spasmodically. It produces a good grade of ore and has recently been profitable. No estimate of ore in sight was turned in by the company, but Dr. Leith estimates it at 500,000 tons.

VOLUNTEER.

This property is really producing at present soft ore, but it has in former years produced hard ore. It is not much more than a prospect. It only reports 30,000 tons in sight, but some drilling indicates a considerable ore body and I place its future expectation at 150,000 tons.

LAKE SUPERIOR HARD ORE.

There is some uncertainty as to the location of certain tonnages reported by the Oliver Iron Mining Company for the Lake Superior group. The Hard Ore, Section 16 and Section 21 mines are treated as a unit. I take it that any mistakes in apportioning tonnage to these mines will not be of consequence on account of unity of ownership. Dr. Leith's inquiries at the company's office showed that they counted on the Hard Ore mine for 1,470,000 tons in sight. A neighboring property which will undoubtedly be operated by this plant shows by drilling the continuation of an ore body worked out by the Cleveland Cliffs Company at the old Morro mine. The ore is on an 80 acre tract. From drill records a rather optimistic estimate was made by the local engineers of 1,500,000 tons, but the Morro mine accounts for a final total of only 900,000 tons. I do not think more than 800,000 tons should be credited to this reserve. This makes a total of 2,270,000 tons for the old Hard Ore mine.

This is an interesting old property which has been worked for more than 50 years and apparently is good for 20 years at a moderate output.

SECTION 16.

Some of the ores from this property are soft ores. The amount reported in sight is 5,311,355 tons. The bottom level 1,080 feet deep shows an area in ore of 168,000 square feet. On account of the dense character of the ore, only 8 or 9 cubic feet is required for a ton. Below this level ore is shown to go down 155 feet. Now since the bottom level shows an area capable of producing about 20,000 tons per vertical foot, we might assume that if the ore body holds its volume this increase of depth would yield about 3,000,000 tons. Dr. Leith reports a probable extension amounting to 4,135,000 tons and an expected total of 9,446,000 tons. Dr. Leith and I both agree that this estimate seems rather optimistic, but, at any rate, the tonnage to be counted on is surely sufficient to keep up the production to the capacity of the equipment, say 300,000 tons a year for twenty-five years. This is long enough to establish the present value.

CHAMPION MINE.

This property has been working spasmodically for many years. Its bottom level is 1,984 feet deep with an area of 40,000 square feet. The amount reported in sight is 1,625,000 tons. This with the former shipments of 4,413,000 tons makes the mine account for more than 6,000,000 tons to its present depth. As in the case of most of the other mines of this class where there is no considerable deterioration, I think it fair to assume that an additional 20% can be added safely. On this basis the mine can produce 2,825,000 tons, sufficient to maintain an output of 100,000 tons a year for twenty-eight years.

THE CLIFFS SHAFT.

This mine reports available 2,167,000 tons. A certain area has a possibility of adding 1,800,000 tons more, but as nothing is sure, I make only a slight addition to the tonnage reported available, bringing it up to 2,500,000 tons. This is sufficient to keep the mine going at 250,000 tons a year for ten years.

NORTH LAKE NO. 2 ORE BODY.

This property reports 594,000 tons.

Cleveland Cliffs Co. reports drilling in the vicinity of Ishpeming on which Dr. Leith estimates 629,000 tons of ore not at present available.

VALUATION IN DISTRICT NO. 6.

These mines are generally long-lived and while some moderate increase of cost may be expected in the future, the conditions may be counted on to remain substantially as they have been in the past. The tabulation shows an expected annual tonnage of 1,224,000 tons as against an average tonnage shipped of slightly under 800,000 tons. The difference here is apparent, not real, because the shipments from the Lake Superior group have not been properly apportioned between the hard and soft ore mines.

The total valuation of the group is $12,132,000 on a total expected tonnage of 21,667,000 tons.

DISTRICT NO. 7. MARQUETTE SOFT ORE MINES.

This district rivals the Iron River in its promise for the future. It is hardly possible to give a summary of the past shipments of these mines because the shipments reported include very large mixtures from the mines of District No. 6.

Dr. Leith has the following to say regarding this group:

"The ore bodies are located with the Negaunee formation in its middle and lower horizons and show great variety of shape. In the Negaunee basin, it is a gently folded and faulted sheet, with comparatively low pitch to the south of west. In the Prince of Wales, Breitung No. 2, Mary Charlotte, Rolling Mill and Cambria and Hartford areas the tabular development is less well marked, the ore bodies occurring in more or less shallow channel-like lenses in the jasper with relatively low pitch with great local irregularities and cut by dikes. In the Lake Angeline area the ores are in sharp troughs in greenstone. The bottoms of these troughs have relatively low pitch."

"The aggregate total area of bottom levels of the mines of this group is about 1,045,000 square feet, but in view of the fact that the ore bodies have, in general, a low pitch, this aggregate area cannot be fairly compared with the areas of the hard ore mines in this district, or of the ores of the Menominee, Crystal Falls, Iron River and Gogebic districts. More closely correlative would be the area of a section across the pitch. With a flat pitch the projection of present bottom levels downward would involve so large a lateral migration that in a number of cases they go off the property. It is apparent also with the flatness of the pitch that the areas or cross-sections in adjacent properties are frequently duplicates, the same ore body running through both properties and being cut at different elevations."

"Drilling in the soft ore horizon has disclosed a vast amount of ore and has opened up possibilities which will not be exhausted for many years. The most notable results of this drilling have been in the area bounded on the north by the Negaunee, Maas and Cambria mines and on the southeast by the Mary Charlotte and Rolling Mill. There is scarcely a forty in this area which has either not shown ore or does not lie in such relation to discoveries as to indicate a strong probability of ore. The ore has been cut to a maximum depth of 2,375 feet."

The soft ores lying in the middle or upper portion of this formation upon sills of greenstone were more easily accessible in earlier days and have been mined extensively for many years. The end of these deposits is, in many cases, measurably in sight.

A very large amount of the ore indicated by drilling is not at present available on account of certain complications of ownership. One company alone reports 40,000,000 tons in sight, of which only 23,000,000 tons are available. A very large additional tonnage was not reported at all. I do not believe that even half of the probable future tonnage of this district is even indicated by drilling. Nothing is known as to the probable downward extent of the ore. One is not indulging in optimism to expect this group of mines to produce 100,000,000 tons.

However, in most cases the amount of ore reported or indicated is enough to continue the life of the present mine for a sufficient period to cover approximately the whole present value of the district. As remarked above, a continuation of life beyond twenty years adds to the present value very slowly, and wherever the ore supply is sufficient to maintain output for even fifteen years, it is not worth while to be critical about the amount of additions that might be made.

LILLIE, CAMBRIA AND HARTFORD.

These properties are controlled at present by the Republic Iron & Steel Company. They report a total of approximately 900,000 tons of ore which is considered by Dr. Leith a sufficient amount. Probable extensions of the ore bodies of these mines occur on the neighboring Jackson mine.

JACKSON MINE.

The Jackson mine is owned by the Cleveland Cliffs Iron Company. This property is a section of land (640 acres) which has formerly produced large tonnages of hard ore in upper horizons. Soft ores will certainly be found on it to a certain extent, probably a very large extent, but the only place where ore is actually indicated is in some drill holes at the northwest corner of the property showing a continuation of the Lillie and Cambria ore bodies on the Jackson. The Lillie, Cambria and Hartford account for a total of 6,800,000 tons.

MARY CHARLOTTE MINE.

This ore body extends across the line of the adjacent Rolling Mill property and will produce 2,775,000 tons, sufficient to maintain a shipment of 200,000 tons a year for fourteen years.

BREITUNG-HEMATITE.

This property, making all allowance for some disputed ownerships can be credited with 2,000,000 tons of ore, sufficient to maintain a shipment of 100,000 tons a year for twenty years.

LAKE ANGELINE & MITCHELL.

The end of both these properties is in sight and tonnage credited to them is only 475,000 tons.

ROLLING MILL.

This property is good for 1,500,000 tons and a life of fifteen years.

LAKE MINE.

This property is bottomed and can only produce 3,700,000 tons more, which will probably be mined in ten years.

NEGAUNEE.

This property reports 13,635,000 tons available. This is sufficient to maintain a probable output of 500,000 tons a year for twenty-seven years.

SALISBURY.

This property is bottomed and contains 584,000 tons in sight. Its life is probably about seven years.

MAAS.

This property reports an available tonnage of 9,662,000 tons. This is sufficient to maintain an output of 400,000 tons a year for twenty-four years.

LAKE SUPERIOR SOFT ORE MINES.

It is difficult to distinguish tonnages reported for these properties from tonnages belonging to hard ore mines. In this connection only one property is listed, namely, Section 21. It is credited with 4,000,000 tons, sufficient to maintain an output of 200,000 tons annually for twenty years.

QUEEN.

This property reports about 1,900,000 tons which will probably last about ten years.

RACE COURSE.

This is a small tract owned by the Oliver Iron Mining Company. They estimate 1,500,000 tons on it, but at present it is not developed and will not be available for many years.

LUCKY STAR.

This property contains a continuation of the Queen ore body crossing its entire length of 1,500 feet. Four drill holes along the line of the ore show an average of 155 feet of ore between depths of 900 and 1,300 feet. Allowing a width of 300 feet for this ore body and an average thickness of 110 feet only, gives us more than 4,000,000 tons which is a very conservative estimate. This ore, however, is not developed for mining and will not be for a number of years.

HARVEY LOTS.

The continuation of the Lucky Star ore body is on the Harvey Lots. Drilling indicates 4,000,000 tons, but it is not developed and is not available on account of uncertainty of location of the ore body with reference to the boundaries. On account of these uncertainties, I value it on a very conservative basis.

VALUATIONS IN DISTRICT NO. 7.

These mines are considerably better developed and more established in the market than the Iron River district, consequently the values are higher. The tonnage put down as expected is somewhat greater. A large group of undeveloped properties are valued at 20 cents per ton in the ground at present. This is based on deducting expected cost of equipment of these properties for production and also deferring profits from them for a period of ten years.

The total value of the properties is $27,825,000, based on a yearly product of 2,263,000 tons and an expected tonnage of 53,145,651 tons.

DISTRICT NO. 8. SWANZY, MARQUETTE COUNTY.

Dr. Leith describes this as an isolated canoe shaped basin of upper Huronian rocks, surrounded by granites south of the Marquette district. The axis of the basin is northwest southeast with minor cross folding. The dips are gentle except where cross-folded. The granite basement is irregular. The ore bodies are principally in the northeast side of the basin and at the ends. One ore body, the Stephenson, is known on the southwest side of the basin. The ores are in tabular deposits with gentle dip. They have been thoroughly explored by drilling in advance of mining operations and the total tonnage of the basin is reasonably well approximated. The total shipments from this field have been 2,420,232 tons. The total available reserve indicated by mining and drilling operations is 6,851,475 tons.

All the mines of this district are controlled by the Cleveland Cliffs Company except the Stegmiller, a nearly exhausted property, controlled by the Oliver Iron Mining Company. The Cleveland Cliffs Company reports for its active mines the following tonnages of available ore:

Stephenson	780,646	tons.
Austin	503,774	tons.
Princeton No. 1	97,064	tons.
Princeton No. 2	1,060,253	tons.
Total	2,441,737	tons.

In addition it reports: Ores discovered by drilling only but not otherwise developed and to some extent of doubtful availability a total of 4,138,738 tons. I consider all of these estimates sufficient.

STEGMILLER.

This property reports 246,000 tons in sight. Dr. Leith adds 20,000 tons for probable ore making a total of 266,000 tons.

VALUATIONS OF DISTRICT NO. 8.

These mines are rather low grade and are high in moisture. Many of the ore bodies discovered by drilling are of doubtful availability on account of underlying enormous masses of quicksand. While the Cleveland Cliffs Company is going ahead with the development and equipment of these mines, the conditions are such that they must be valued on a conservative basis.

The total valuations are $2,530,000 based on an expected yearly product of 456,000 tons, and a total expected output of 6,746,158 tons.

TABULATION NO. 9.

This covers various mines in different ranges which ship ore of much lower grade in iron contents than the ordinary merchantable ores of the Lake Superior region. Dr. Leith has the following to say in regard to them.

"The ores are but little higher in iron than the average of the adjacent iron formation. They are partly open cut and milling propositions and partly underground mines. Their mining at any particular locality depends upon favorable conditions, low phosphorus content or possession of a restricted market, or in the case of the Pewabic and other mines, a need of handling ore of this grade along with higher grades which are being hoisted. So far as we know, any of the mines which have produced this grade can produce it far in the future and estimates of tonnage would be of little consequence. For instance, in the Palmer area an estimate of tonnage of such ore would be enormous, but the limits are so indefinite that an estimate of tonnage is difficult."

"It should not be assumed that there are unlimited quantities of these ores. It is true that there is an enormous quantity with this percentage of metallic iron, but areas are comparatively limited where the phosphorus is exceptionally low and where the conditions allow of cheap mining. Therefore, these ore bodies have a distinct value because of their limitation."

However, the salient fact in connection with these ores is that their market is at present limited and, therefore, the value of the mines is on the whole more a question of certain commercial advantages than of simply an ore discovery.

VALUATIONS OF TABULATION NO. 9.

These mines are valued simply at the amount of their earnings during the past five years. No estimate is made for the probable tonnage that they can depend on. Total valuation is $373,000.

THE VALUE OF UNDEVELOPED IRON LANDS.

It was hoped up to the completion of our investigation that some means would be found of placing a value on unexplored iron ore formation. The final result, however, is a disappointment. Such lands are undoubtedly valuable, but we have not succeeded in finding any logical measure of their value.

The reason for this is that we have no means of knowing, without a very long investigation, what proportion of iron lands are really unexplored. If we could compare an area of fresh iron lands with another area that had been explored and had been proved to contain a certain tonnage of iron ore, we might then rationally assume that the undeveloped land would reduce somewhat in the same proportion, but it has been impossible to make any such comparison.

It must be borne in mind that the iron mines, as well as the copper mines, would lose value every year unless new ore is found to take the place of what is removed. It seems to me that it is a logical position to take in regard to undeveloped mineral lands, that whatever values they may be proved to contain will be appraised as soon as a mine is developed; in other words, the State loses nothing in the long run by not taxing such lands for their mineral value.

SUMMARY of costs, receipts, shipments and other data for the Nine Iron districts for five year period.

DISTRICT NO. 1.

Gogebic County, Michigan.

		Totals.	Per ton.
Number of mines and explorations reported		20	
Wages and salaries paid		$16,632,296 40	
General expenses (not including taxes)		$1,558,705 93	.098
Construction, development and explorations		4,083,864 20	.260
Mining expense		21,207,105 10	1.355
Total cost at mine		$26,849,675 23	1.72
Rail freights paid		6,002,288 37	.40
Lake freights paid		10,585,921 64	.71
Commissions paid		695,520 57	.046
Total expense		$44,133,405 81	*2.876 F. O. B. Cleveland
Total tons sold	15,183,842		
Total tons shipped	15,393,642		
Total tons mined	15,711,053		
Receipts from sale of ore		$65,694,536 07	
Total operating profit of 12 mines		21,944,683 57	
Taxes		992,272 42	
Proportion taxes to operating profits (per cent)		4.55	
Royalties		5,960,403 65	
Profit to companies (12 mines)		15,212,854 39	
Total profits 12 mines including royalties		20,957,419 53	
Total loss to three mines (exploration and development properties not included		678,579 85	
Total tonnage reported in sight		17,354,100	
Tons added by appraiser		25,645,900	
Total tonnage expected		43,000,000	
Average yearly value (expected) per ton		$4 22	
Average cost per ton expected F. O. B. Cleveland		†2 87	
Average profit per ton expected		1 35	
Annual tonnage expected		2,875,000	
Present value of mines		$41,560,000 00	

* The average cost per ton includes mines worked at a loss.

† The expected cost per ton is only for mines expected to work at a profit.

DISTRICT NO. 2.

Iron County, Michigan.

		Totals.	Per ton.
Number of mines and explorations reporting		29	
Wages and salaries paid		$4,411,151 48	
General expenses (not including taxes)		$352,688 31	.087
Construction, development and explorations		3,574,038 89	.895
Mining		5,211,894 90	1.30
Total cost at mine		$9,138,622 10	2.28
Rail freights paid		1,279,487 98	.40
Lake freights paid		1,609,055 90	.54
Commissions paid		260,351 01	.067
Total expense		$12,287,516 99	* $3.287 F. O. B. Cleveland.
Total tons sold	3,848,325		
Total tons shipped	3,820,308		
Total tons mined	3,999,457		
Receipts from sale of ore		$12,740,286 82	
Total operating profit of 9 mines		2,044,106 72	
Taxes		103,907 11	
Proportion of taxes to operating profit (per cent)		5.5	
Royalties paid		844,038 89	
Profits to companies (7 mines)		1,395,354 01	
Total profits 9 mines (including royalties)		1,952,543 49	
Total loss to companies (10 mines)		1,912,320 91	
Total tonnage reported in sight		10,169,213	
Tonnage added by appraiser		31,952,787	
Total tonnage expected		42,122,000	
Average yearly value (expected) per ton		$3 23	
Average cost per ton expected, F. O. B. Cleveland		2 65	
Average profit per ton expected		58	
Annual tonnage expected		1,290,000	
Present value of mines		$17,042,000 00	

*Includes unprofitable mines.

DISTRICT NO. 3.

		Totals.	Per ton.
Number of mines and explorations reporting		25	
Wages and salaries paid		$4,756,223 68	
General expenses (taxes not included)		$437,288 47	.064
Construction, development and explorations		1,789,786 65	.26
Mining		6,565,400 84	.956
Total cost at mine		$8,792,475 96	$1.28
Rail freights paid		2,374,293 64	.40
Lake freights paid		3,267,453 98	.57
Commissions paid		548,504 29	.09
Total expense		$14,982,727 87	$2.34 Includes unprofitable mines.
Total tons sold	6,050,662		
Total tons shipped	6,119,177		
Total tons mined	6,777,255		
Receipts from sale of ore		$20,861,190 27	
Total operating profit (10 mines)		6,361,951 98	
Taxes		131,493 43	
Proportion of taxes to operating profits (per cent)		2.6	
Royalties paid		1,611,190 15	
Profits to companies (8 mines)		4,846,463 22	
Total profits (10 mines) including royalties		6,238,753 13	
Total loss to companies (6 mines) not including explorations		710,684 40	
Total tonnage reported in sight		1,233,900	
Tonnage added by appraiser		6,820,100	
Total tonnage expected		8,054,000	
Average yearly value (expected) per ton		3.52	
Average costs expected per ton F. O. B. Cleveland		2.36	
Average profit per ton expected		1.16	
Annual tonnage expected		880,000	
Present value of mines		$6,297,000 00	

DISTRICT NO. 4.

		Totals.	Per ton.
Number of mines and explorations reporting		12	
Wages and salaries paid		$9,322,449 20	
General expense (not including taxes)		$971,447 21	.097
Construction, development and explorations		1,915,320 33	.192
Mining		11,289,470 33	1.128
Total cost at mine		$14,176,237 87	1.417
Rail freights paid		3,483,420 04	.40
Lake freights paid		5,369,237 62	.60
Commissions paid		66,661 27	.07
Total expense		$23,095,556 80	2.48 F. O. B. Cleveland.
Tons sold	9,391,360		
Tons shipped	9,335,812		
Tons mined	10,052,564		
Receipts from sale of ore		$34,103,131 46	
Total operating profit of ten mines		11,040,230 75	
Taxes		795,696 22	
Proportion of taxes to operating profit (per cent)		7.24	
Royalties paid		2,395,619 41	
Profit to companies 9 mines		7,885,624 86	
Total profit—mines (including royalties)		10,249,066 96	
Total loss to companies, two		69,365 83	
Total tonnage reported in sight		9,177,348	
Tons added by appraiser		9,055,652	
Total tons expected		18,233,000	
Average yearly value (expected) per ton		$3.46	
Average cost per ton expected F. O. B. Cleveland		2.64	
Average profit per ton expected		.82	
Annual tonnage expected		1,540,000	
Present value of mines		$11,391,000 00	

DISTRICT NO. 5.

Baraga County, Michigan.

		Totals.	Per ton.
Number of mines and explorations reporting		3	
Wages and salaries paid		$565,969 48	
General expenses (not including taxes)		$48,919 32	.065
Construction, development and explorations		159,844 44	.214
Mining		951,722 56	1.28
Total cost at mine		$1,160,486 32	1.56
Rail freights paid		228,479 12	.35
Lake freights paid		398,492 21	.61
Commissions paid		40,147 35	.06
Total expense		$1,827,605 00	2.58
Tons sold	657,370		
Tons shipped	657,370		
Tons mined	744,603		
Receipts from sale of ore		$1,807,495 98	
Total operating profits, three mines		45,377 44	
Taxes		7,331 05	
Proportion of taxes to operating profit (per cent)		16.2	
Royalties paid		136,601 62	
Profits to companies—mines		None	
Total profits three mines (including royalties)		38,046 39	
Total loss to companies, three mines		98,555 23	
Tons reported in sight		1,864,185	
Tons added by appraiser		199,815	
Total tonnage expected		2,064,000	
Average yearly value (expected) per ton		$2.98	
Average cost per ton expected, F. O. B. Cleveland		2.61	
Average profit per ton expected		37	
Annual tonnage expected		75,000	
Present value of mines		$335,000 00	

DISTRICT NO. 6.

Marquette County, Michigan.

		Total.	Per ton.
Number of mines and explorations reporting		11	
Wages and salaries paid		$5,296,704 30	
General expenses (taxes not included)		$582,605 38	.14
Construction, development and explorations		1,173,335 39	.29
Mining		6,801,080 83	1.67
Total cost at mine		$8,557,021 60	2.10
Rail freight paid		1,230,335 82	.40
Lake freight paid		2,359,387 30	.60
Commissions paid		59,900 93	.02
Total expense		$12,206,645 65	$3.12
Tons sold	3,873,785		
Tons shipped	3,888,557		
Tons mined	4,078,863		
Receipts from sale of ore		$17,015,407 56	
Total operating profit, 6 mines		5,246,934 10	
Taxes		495,505 01	
Proportion of taxes to operating profit (per cent)		9.45	
Royalties paid		262,329 14	
Profit to companies, 6 mines		4,723,752 76	
Total profits, 6 mines (including royalties)		4,866,081 90	
Total loss to companies, 2 mines		572,825 00	
Tons reported in sight		11,134,355	
Tons added by appraiser		10,532,645	
Total tonnage expected		21,667,000	
Average yearly value per ton expected		$4 30	
Average yearly cost per ton expected		3 32	
Average profits per ton expected		.98	
Annual tonnage expected		1,224,000	
Present value of mines		$12,132,000 00	

DISTRICT NO. 7.

Marquette County, Michigan.

		Totals.	Per ton.
Number of mines and explorations reporting		20	
Wages and salaries paid		$12,011,515 90	
General expenses (not including taxes)		$1,395,899 35	.12
Construction, development and explorations		2,140,866 05	.19
Mining		15,107,981 23	1.33
Total cost at mine		$18,644,746 63	1.64
Rail freight paid		3,064,947 71	.32
Lake freight paid		5,424,983 28	.65
Commissions paid		134,029 88	.01
Total expense		$27,268,707 50	$2.62
Tons sold	10,744,791		
Tons shipped	10,830,611		
Tons mined	11,354,811		
Receipts from sale of ore		$39,605,117 47	
Total operating profits, 15 mines		12,467,025 65	
Taxes		865,028 59	
Proportion taxes to operating profit, per cent		6.98	
Royalties paid		1,859,944 05	
Profit to companies, 13 mines		9,867,181 86	
Total profits, 14 mines (including royalties)		11,654,992 00	
Total loss to companies, 4 mines		255,584 53	
Tons reported in sight		35,961,538	
Tons added by appraiser		17,184,113	
Total tonnage expected		53,145,651	
Average yearly value per ton (expected)		$3.77	
Average yearly cost per ton (expected)		2.69	
Average profit per ton (expected)		1.08	
Annual tonnage expected		2,363,000	
Present value of mines		$27,825,000 00	

DISTRICT NO. 8.

Marquette County, Michigan.

		Totals.	Per ton.
Number of mines and explorations reporting		13	
Wages and salaries paid		$2,158,212 35	
General expense (not including taxes)		$172,674 60	.082
Construction, development and explorations		307,771 22	.148
Mining		3,312,786 07	1.580
Total cost at mine		$3,793,231 89	1.81
Rail freights paid		311,706 73	.32
Lake freights paid		418,475 85	.65
Commissions paid		....	....
Total expense		$4,523,414 47	2.78
Tons sold	1,669,737		
Tons shipped	1,670,263		
Tons mined	2,095,723		
Receipts from sale of ore		$5,682,757 47	
Total operating profit, 6 mines		1,267,967 36	
Taxes		99,687 11	
Proportion of taxes to operating profit (per cent)		7.9	
Royalties paid		540,348 62	
Profit to companies, 1 mine		1,047,803 59	
Total profit, 2 mines (including royalties)		1,219,975 79	
Total loss to companies, 3 mines		528,496 32	
Total tonnage expected		6,746,158	
Average yearly value per ton expected		$3.60	
Average cost per ton expected		2.94	
Average profit per ton expected		.66	
Annual tonnage expected		456,000	
Present value of mines		$2,530,000 00	

DISTRICT NO. 9.

Various scattered low grade mines.

		Totals.	Per ton.
Number of mines and explorations reporting		11	
Wages and salaries paid		$620,145 06	
General expenses (taxes not included)		$59,960 53	.045
Construction, development and explorations		279,101 91	.22
Mining		845,056 92	.66
Total cost at mine		$1,184,119 36	.92
Rail freights paid		454,062 59	.40
Lake freights paid		502,930 70	.60
Commissions paid		72,834 61	.10
Total expense		$2,213,947 26	2.02
Tons sold	1,171,024		
Tons shipped	1,179,719		
Tons mined	1,293,658		
Receipts from sale of ore		$2,261,830 18	
Total operating profit, 4 mines		386,208 35	
Taxes		21,327 20	
Proportion taxes to operating profit (per cent)		5.45	
Royalties paid		154,427 35	
Profit to companies, 4 mines		278,364 85	
Total profit (including royalties)		374,323 47	
Total loss to companies, 5 mines		406,236 48	
Tons reported in sight		1,323,074	
Tons added by appraiser		None	
Total tonnage expected		1,323,074	
Average yearly value per ton expected		Valued only on past record.	
Average cost per ton expected			
Average profit per ton expected			
Present value of mines		$373,000 00	
Annual tonnage expected		....	

THE VALUE OF COAL PROPERTY AND COAL RIGHTS IN THE STATE OF MICHIGAN.

BY H. M. CHANCE.

Bay City, Mich., August 1, 1911.

To Mr. J. R. Finlay, Appraiser of Mines, Board of State Tax Commissioners, Houghton, Mich.:

Dear Sir—The data herewith submitted have been collected and prepared in accordance with my understanding that in each case you desire to reach such valuation as would represent, as nearly as possible, the price an investor would be justified in paying, if a purchase of the property were in contemplation. The location of proven areas of workable coal is shown by the accompanying map, which was prepared by Mr. H. F. Lunt to illustrate this report. This map was constructed from data taken directly from the mine and property maps of the operating companies. All of the figures used in this report giving the areas or acreages of proven coal territory have also been taken from the mine and property maps and other records of the operating companies or owners of proven territory, and the average thicknesses of the coals as adopted and used in computing tonnage yield, are likewise taken from the records of borings as entered by owners and operators upon their property and mine maps.

In attempting to outline a method by which such valuation may be determined, giving due weight to the modifying force of those facts which govern and fix values, it becomes necessary to review with care and in some detail the physical conditions present in this coal field, to inquire into the commercial and competitive relations it bears to other coal-fields and to investigate the economic, as well as the physical conditions which affect the cost of mining.

At an early stage of this inquiry it became evident that any Michigan property containing a coal-bed which in thickness, and in the quality of the coal, and in conditions under which it was mined, is fairly comparable to the average thickness, quality and mining conditions of Ohio or West Virginia coal-beds, must by reason of its location be valuable. For example, if Michigan coal could be sold at competitive Michigan points at a price equal to the cost of mining and delivering Ohio coal, and could be mined at the cost of mining Ohio coal, the profit to the Michigan operator delivering coal in the territory north of an east and west line drawn through Lansing, would range from 60 cents to $1.60 per ton, or in other words, to the difference in the cost of transportation. Prospective profits so much larger than those usually earned by coal-mining enterprises would however, doubtless quickly bring about the opening of many mines, with such increase in production and competition as to destroy the possibility of such profitable operation.

While no coal has yet been found or developed in Michigan which is thus comparable in thickness, quality, mining conditions, etc., to average Ohio coal, and while the Michigan coals intrinsically are not worth as much per ton as average Ohio coal and are more expensive to mine than Ohio coals; in many cases there yet remains a satisfactory margin of possible profit between the cost of mining in this field and the delivered cost of other competitive coals. Unfortunately, however, the Michigan output has been in excess of the local demand for coal of this grade, and competition among Michigan operators has often reduced the average selling prices to less than the cost of mining.

Similar commercial and economic conditions are not uncommon in Indiana, Illionis, Western Kentucky, Ohio and other mining districts, but such trade conditions do not exist for any considerable period in any district. Unprofitable prices inevitably cause the temporary or permanent closing of a considerable number of mines, thus reducing the output until increasing consumption establishes equilibrium between production and demand, and prices are thus naturally adjusted to averages at which the business can be conducted at a fair profit upon the invested capital. Such has been the past history of coal mining in nearly every coal mining district in the United States and we have every reason to anticipate like conditions in this coal-field.

Within the last five years the output of the Michigan mines increased more rapidly than the local demand, and competition among producers resulted in small and unsatisfactory profits to some, and disastrous losses to others, but these facts do not in themselves justify the conclusion that Michigan coal lands are less valuable than coal lands in other districts. Recently the situation has been changed by the temporary closing of some mines, by the exhaustion of some and by the permanent closing of others.

From my study of the situation it seems patent that the trade is rapidly approaching a period in which the Michigan mines consistently can earn profits commensurate with those earned in other districts. If this be true, then coal of workable thickness and marketable quality should be as valuable acre for acre, or ton for ton, in Michigan as in any other district.

VALUE OF PLANT AND IMPROVEMENTS.

In conducting this investigation it has been found that in many cases the life of any property, that is the term during which it can be expected to continue in operation, is involved in more or less uncertainty, depending upon the accuracy and thoroughness with which the property has or has not been drilled. The value of the mining plant and improvements, (the hoisting engine, fans, boilers, tipple, tracks, shafts, entries, etc.,) depends not upon their first cost, present condition or value as second-hand material or junk, but upon the tonnage of coal which the plant will raise to the surface. After it has performed this work, its value at second-hand material or junk prices is relatively small. Hence a logical method of reaching the value of such mining property is to determine the value of the developed and proven coal tonnage, for this represents the whole profit, and therefore very nearly the whole value of the property, including the present value or first cost of the plant and improvements; for when this coal is mined the property is exhausted and the plant and improvements may be worth a small fractional part of their first cost.

I have therefore aimed to so present the facts as to make it possible to reach values based upon the proven tonnage of each property by a system applicable to all parts of the coal-field.

METHOD OF FIXING VALUES.

In using this system it becomes necessary to assume as a basis, a value which shall represent the present money value of a ton of coal existing under average mining conditions and which is to be mined in the immediate future, that is to say in the present year. If such value be fixed at 10 cents per ton, this is equivalent to a value of $300 per acre for a bed of coal 3 feet thick, and which will produce 3,000 tons per acre.

Having fixed upon some such unit value per ton as a base, it becomes necessary to determine what additions or deductions must be made to represent differences due to thicker or more cheaply mined coal, or to thinner coal or coal more expensive to mine, and to represent the difference in value between areas actually being worked and those which are not yet actually developed by shafts, as well as those modifications which must be made for properties the development of which may be deferred, or which will not be exhausted for many years.

The mere fact of developing a bed of coal, that is, the actual opening of a coal-bed by shafts and the commencement of mining operations, is usually thought to double the coal value, and in other mining districts the opening and working of coal, as a matter of fact, usually does double the prices at which such lands can be sold. If we adopt this as a measure of relative values, the value of undeveloped coal will be taken at one-half of the value of the same coal in developed territory and if the base value of developed coal be assumed at 10 cents per ton then the value of undeveloped coal will be 5 cents per ton. In this coalfield experience has amply shown that owing to unforseen irregularities in the coal and to insufficient or unreliable drilling, only about one-half of the anticipated output usually is obtained from any area, so that in this Michigan coalfield it becomes necessary to make a further deduction, by cutting the above value in half, thus bringing the value of undeveloped territory down to about one-quarter of the base value, or upon the above assumption, to 2½ cents per ton.

To determine the present money value, these base values must be discounted for the term of years elapsing before mining is begun and for the term necessary to exhaust the property.

Assuming that existing and projected operations will be able to supply the market requirements for the next ten years and that the average life of collieries hereafter opened will be ten years, the present money value of a ton of coal in undeveloped territory (2½ cents discounted at 5 per cent interest for a term of 10 years, and distributed through a further term of 10 years) may be taken at about 1¼ cents per ton; equivalent for a coal-bed 3 feet thick and estimated to yield 3,000 tons per acre, to a value of $37.50 per acre.

In cases in which undeveloped lands are opened and worked in a shorter period than ten years, the discount period is correspondently shorter and the present value upon this basis may be 1½, 1¾ or 2 cents per ton, and the base will also be increased where the thickness of the coal, its quality or the mining conditions justify such increase.

AREA OF COALFIELD.

What is known as the Michigan coalfield has been shown by the maps and report of the Geological Survey to include an area of 15,000 square miles, including all of 13 counties and portions of 14 counties. That is, the formations which contain coal underlie in whole or in part, the surface of these 27 counties. The presence of coal has been demonstrated in these formations at hundreds (or thousands) of places by bore holes drilled for water or for salt and by wells dug for water, and in some localities by many holes drilled for the purpose of learning the thickness and quality of the coal. The information obtained in this way at many localities appeared to justify the sinking of shafts and the mining of coal and mines have thus been opened and worked in nine counties. Some of these enterprises were unsuccessful from the outset and many others were abandoned either because the coal was too thin, the mining conditions unfavorable or because the workable coal was exhausted.

LOCATION OF MINES.

At present mining is being conducted in seven (7) counties, as follows:

Bay county	10 mines
Saginaw county, (including shafts completed)	17 mines
Tuscola county	1 mine
Genesee county	1 mine
Shiawassee county	2 mines
Ingham county	1 mine
Eaton county	2 mines
Total	34 mines

PECULIARITIES OF THE MICHIGAN COALFIELD.

In most of the coalfields of the United States the workable beds of coal are regular and persistent in thickness and quality over large areas. When this condition is known in any district coal lands become valuable for their coal contents, and the mining, mineral or coal rights become marketable not only to coal operators and those engaged in the coal business, but also to investors who do not expect an immediate return on their investment. In such districts and under such conditions the present money value of the coal, distinct and apart from the value of the land, may readily be determined by the price at which it can be sold.

In the Michigan coalfield, so far as is now known, the workable coal is confined to irregular areas of small size and these areas in the aggregate comprise a relatively small portion of the whole coalfield.

WORKABLE THICKNESS.

Under present mining and economic conditions in Michigan there is no possibility of profitably working coal-beds, the average thickness of which is less than 2 feet and 6 inches. Any coal bed of less thickness unhesitatingly can be classed as not workable. The time will doubtless come when coal of such thickness will be workable, but this contingency is remote and uncertain and is insufficient to add any measurable present value to lands containing such coal.

The same statement is broadly true of lands containing coal less than 3 feet thick, for except in rare instances, this is the present economic limit and is based upon the experience of those who have mined coal in this field, that coal less than 3 feet thick cannot at present be considered workable. In connection with mines working coal-beds more than 3 feet thick, it often may be possible to extend the mine workings into marginal areas (contigious to the thicker coal) in which the thickness may shrink to less than 3 feet, and when the roof is good and the coal of good quality, and other conditions are favorable to cheap mining, such workings may extend to and include such marginal areas in which the coal shrinks to 2 feet and 6 inches.

We may therefore summarize the conditions which at present are necessary to constitute a workable tract of coal land.

1. The coal-bed must have an average thickness of not less than 3 feet.
2. Marginal areas showing a thickness of less than 2 feet 6 inches must be excluded.
3. These thicknesses must be of coal, and not of coal and slate partings combined.
4. The quality must be fairly comparable to that produced by other mines of the district.
5. The coal must have a fairly good roof and sufficient rock cover.
6. Other mining conditions must be fairly comparable to those of other mines in the district, so that coal can be mined at a cost not greatly exceeding the cost per ton of other mines in the same district.

YIELD PER ACRE.

Owing to poor roof, irregular thickness, risks involved in robbing out pillars and the irregular shapes or conformation of the workable areas, the yield per acre, per foot in thickness, is relatively small. From 1,200 to 1,350 tons per acre per foot in thickness are average yields obtained in other mining districts, but in this coalfield a yield of about 1,000 tons per acre for each foot in thickness will probably represent average results, and this figure has been adopted and used in making all computations of tonnage as given in this report.

VALUE OF UNPROVEN TERRITORY.

As the coal-beds lie deeply buried beneath the surface, thorough prospecting by drilling is necessary to prove the existence of workable coal in any locality and to define the size and shape of the workable area. We cannot learn that lands within the limits of this coalfield, which have not been explored for coal by drilling, are considered more valuable by reason of the possibility that workable coal may underlie the surface, nor can we learn that the mineral rights, or rights to mine coal from such lands is marketable at any price. The possible existence of workable coal in undrilled territory is regarded as so vague and uncertain that investors have not in the past, and are not now, willing to purchase the mining right or mineral right to such lands.

In view of these facts and conditions it seems reasonable to conclude that neither the coal mining rights nor the coal existing in unproven territory in the Michigan coalfield has at present any definable money value; that is, they have no present value.

VALUE OF PROVEN TERRITORY.

The finding in a single drill hole of a bed of coal of workable thickness does not prove the existence of a workable area, but merely indicates the possible existence of such an area, and to prove such area a sufficient number of holes must be drilled to show that such thickness exists over an area large enough to justify an expenditure necessary for its development.

FACTORS AFFECTING VALUES.

The quality of the coal has an important bearing upon its value, and the quality and prices of those coals from other districts with which it is in competition are equally important factors in determining values. The thickness and mining conditions of any coal-bed and the cost of mining labor in the district, fix the cost of mining. Profitable operation is possible only when the coal is sold at a fair margin above the cost of production, and this selling price in turn depends upon the quality of the coal as compared with the quality of the coal from other competitive districts and upon the prices at which such competitive coals are sold. While it may be beyond the province of this report to go into all these matters in detail, and while it is impossible in the time available for this purpose to collect complete data covering every phase of the matter, it is nevertheless necessary to recognize the important bearing of these features of the business as affecting the probable average profit per ton, for all values ultimately must be based upon the average profits of the business.

Without attempting to go into a discussion of minor details it will be sufficient to summarize these conditions as follows:

The thickness of coal now being worked in the Michigan mines is less than that of competitive coals of the Ohio and West Virginia coalfields and the mining conditions present in this state are unfavorable to cheap mining as compared with those of the Ohio and West Virginia coalfields. The principal adverse physical conditions are:

1. All coal must be mined through shaft.
2. Quantity of water to be pumped is relatively large.
3. Irregularity in the thickness of the coal.
4. Smaller average size of the coal-beds.
5. Small size of the workable areas.
6. Troublesome roof, requiring expensive timbering.
7. Small demand for coal during the summer months.

LABOR COST AND MINING SCALE.

The mining scale in Michigan is higher than in the competitive Ohio and West Virginia districts, the wage scale generally is higher and the extra allowances received by the Michigan miners for narrow work, rock, etc., are usually computed by more liberal methods than is customary in other coalfields. These conditions naturally tend to increase the cost per ton.

The cost of dead-work under this scale and for a 3 foot bed of coal normally should not exceed 25 or 28 cents per ton, but in practice it is seldom less than 30 cents and often reaches 40 cents or more. The cost of materials and supplies is generally excessive, and instead of a charge of 8 to 15 cents for these items, this cost usually ranges around 30 cents per ton. Miscellaneous labor inside and outside show costs of about 25 to 30 cents, and this is increased by the smaller output during summer; overhead charges of 10 to 15 cents added to the mine scale ($1.01 per ton for screened coal) price on run-of-mine basis explains why the cost is about $1.60 per ton.

QUALITY OF MICHIGAN COAL AND COMPETITIVE FUELS.

In quality the Michigan coal is distinctly inferior to the Ohio and West Virginia coals which are shipped into Michigan. These foreign coals usually contain less moisture, less sulphur and less ash and are therefore of correspondingly higher value, and this difference is soon discovered when the price is based upon the thermal value as measured by the number of British Thermal Units (B. T. U.) generated in actual combustion tests. It must not, however, be understood that the Michigan coals are not fairly good steam fuels or that they are not satisfactory fuels for domestic use. The difference in quality represents a difference in value averaging from 20 to 40 cents per ton,—that is, some of the Michigan coals are worth from 20 to 40 cents less per ton than average Ohio and West Virginia coals.

COST OF MINING.

The disadvantages under which these Michigan coal mines are operated increase the cost of mining as compared with the average cost in Ohio, by about 60 to 80 cents per ton, and by about 75 to 90 cents per ton as compared with the average cost in West Virginia. A large part of this increased cost is due to the losses in maintaining the mines throughout the summer, when nearly all of them are worked at a loss, or are maintained in working condition at a cost that must be charged up to the cost of mining when mining is resumed in the autumn.

ADVANTAGES OF THE MICHIGAN COAL.

The operator in the Michigan coalfield has for a natural market all that portion of the lower peninsular of Michigan lying north of Lansing and Grand Rapids and especially that section immediately surrounding Saginaw and Bay City, and lying north, west and northwest of those two cities.

In the above described region the Michigan coal has a natural protection, which the freight rates on the Ohio and West Virginia coals interpose, amounting to from $1.40 to $1.60 and more per ton from the Ohio districts and about 25 cents per ton additional on coal from the West Virginia districts. Hence it is apparent that the Michigan coal

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mines should control the market and furnish the greater portion of both steam and domestic fuels consumed in this district, and that this business should be conducted at a fair margin of profit.

This conclusion may appear to be at variance with the facts, for the past history of this coalfield presents many instances of unsuccessful operations and of the failure of a considerable number of attempts to mine coal in different parts of the field. In all of these cases I believe, however, that the cause of failure can be traced to inadequate drilling to determine the thickness, quality and extent of workable coal, to inexperience in the business, to increasing the output until the production was in excess of the local market demand, to attempting to market coal beyond the natural limits of the district or to destructive competition with other mines of the same district. I believe that by confining the sales of this coal to the markets to which natural conditions tend to restrict it the operators ultimately should succeed in placing the industry upon a stable and satisfactory business basis.

For these reasons I believe that the same principles commonly applied in appraising values elsewhere should be used in determining values in this coalfield, and that the method suggested above as applied to this district will fix values which are rational and which will harmonize with those established in other coal mining districts.

UNIT OF VALUE.

In suggesting ten cents (10 cts.) per ton as a unit of value I have assumed that the industry can and will be so conducted as to produce a net profit (after deducting from the selling price of the coal, all costs incident to carrying on the business, including depreciation, sinking fund, and amortization of investment) sufficient to justify an average minimum value of ten cents per ton. If the industry were more firmly established upon a profitable basis this unit of value would naturally be larger, and a slight improvement in trade conditions only would be necessary to justify an increase in this unit to 18 or 20 cents. The principal additions to or deductions from this basic unit of value have already been discussed, but in some cases other allowances or adjustments may be required to represent variations in value caused by varying thicknesses of the coal and by marked differences in quality or in mining conditions.

LEASE-HOLDS AND ROYALTIES.

Most of the coal territory controlled by present operators is held under leases, the terms of which give to the lessee the exclusive right to mine and remove all of the coal. The royalties paid under these leases have commonly ranged from five (5) to ten (10) cents per ton, but in exceptional cases, and especially at quite small mines, higher royalties have been paid. Many of the leases originally made at or about 10 cents per ton have from time to time been re-adjusted to a lower basis, and the average royalty now paid is probably little more than five cents per ton, and we understand some leases have been made at less than 5 cents per ton. Most of the leases require a certain minimum payment per year, and in the case of certain undeveloped properties this payment is usually based upon the number of acres leased, a common price being from $1.00 to $2.00 per acre per annum, but this annual payment is in many cases also re-adjusted to a lower basis. By the terms of these leases the money so paid is usually defined as an advance payment of royalty upon coal to be mined after mining operations are commenced.

Within the past six or eight years large areas have at times been leased and held by operators and by others for speculative purposes, but most of the leases so held have been allowed to lapse by non-payment of the annual "advance royalty," and with few exceptions the present policy of individuals and corporations engaged in mining and in prospecting coal land is to retain control only of territory which by drilling has been proven to contain coal of workable thickness and quality.

STABILITY OF VALUES.

With increasing population and still more rapidly increasing demand for fuel, coal land and coal mining rights are steadily growing in value in almost every coalfield in the United States, and it is reasonable to anticipate a like increase in value in the Michigan coalfield. The consumption of coal in the United States has about doubled every ten years for the last sixty years, and coal land values have generally kept pace with this rate of increase. In some localities coal land has increased in value four-fold and six-fold in the past ten years, but these are extreme examples of abnormally rapid increase in market value. I believe that the proven areas of workable coal in this coalfield will surely increase in value proportionately with the increase in population and in the consumption of coal. Conditions that would tend to decrease the value of these lands would be the discovery, in Michigan, of larger areas of better and thicker coal, or radical reductions in freight rates such as would enable the operators of competing districts to deliver coal at a price less than the cost of mining in the district.

VALUE OF PLANT AND EQUIPMENT.

While the value of the plant and improvements at any colliery after the coal is exhausted, if restricted to the value of the machinery and equipment at second-hand or at junk prices, is relatively small and unimportant, yet to reach an appraisal which shall represent such value as a purchaser might be justified in paying for a property, it becomes necessary to add to the coal land appraisal as determined by this unit system, a sum to represent what may be termed a salvage value of the plant. This salvage value is greater to operators who may be able to use the machinery at other mines than to those who having no use for it must dispose of it at the best price that can be obtained at the open market, but such method of reasoning is not justified, because an operator desiring or willing to use second-hand machinery can usually buy it at current second-hand prices, and it therefore seems proper that the salvage value at which the mining plant, that is the movable machinery and equipment, is appraised should be based upon current second-hand prices for machinery of this type.

This salvage value at collieries that are fairly well equipped will range from $3,000 or $4,000, up to perhaps $20,000 or $25,000 depending upon the class and type of machinery and equipment, and upon its length of service and state of repair.

It will be understood that the word "plant" is used to include boiler, machinery, buildings, tipple, and other permanently installed improvements; that the word "equipment" is used to include mine cars, mules, track, electric wiring, electric locomotives, mining machines, compressors, tools, piping, supplies on hand and other movable personal property; and that the word "improvements" is used to include the shafts, air shafts, pumps, bore holes, entries, cross-cuts, railroad road bed construction, reservoirs, and all mine and shaft timbering, but that the term "plant" is often used to include "plant," and "equipment" as above defined.

One of the advantages of establishing a system of appraisal based upon unit values, such as has been above outlined, is that such system lends itself to re-adjustments which may be required at any time by changes in the financial condition of the industry. Under normal or prosperous trade conditions these units might be increased by 100 or even 200 per cent without exaggerating the value of the properties.

PROVEN COAL IN MICHIGAN.

County.	Acres.	Tons.	Appraised value.
Bay	4,607	14,945,746	$484,709
Saginaw	3,297	9,556,583	350,924
Midland	343	1,029,000	12,862
Tuscola	10	35,000	3,500
Shiawassee	260	780,000	9,750
Genesee	936	2,836,333	
Ingham	0		
Eaton	0		
Clinton	0		
Jackson	0		
Total	9,453	29,182,662	$861,745

Average value per acre of appraised land $101.18.

SALT, GYPSUM, CEMENT AND BRICK CLAY.

The conclusion arrived at with reference to these properties is that they are not mines at all, and cannot logically be appraised on a mining basis. This conclusion is based on the fact that none of these materials is inherently valuable in the ground, its value depending entirely upon the labor that is put upon it, or on its commercial situation.

The reasons for this conclusion are dwelt upon to some extent in preceding portions of this report. The immediate cause of our arriving at it was that companies engaged in producing or manufacturing these various materials objected, in many cases, to being classed as mining concerns. The following letter gives the position of some of these companies very clearly:

Manistee, Mich., June 23, 1911.

J. R. Finlay, Appraiser of Mines, Houghton, Mich.:

Dear Sir:—Your favor of the 12th inst., enclosing blanks for statement, is received.

We assume that you call on us for these statements because we are engaged in the manufacture of salt. Permit us to say that we are not mining salt, never have mind it and never can do so. The situation is that we pump to the surface brine for a distance of about two thousand feet and evaporate this brine into salt. That is the only way in which we can manufacture salt.

You should also understand that the evaporation of salt is an adjunct to and incidental to our lumber business. We have a great deal of waste, such as saw dust, small edgings, etc., etc., which we use to make steam for the evaporation of salt. This waste material makes a great deal more steam than can be utilized in running our mills, and the surplus is used for the evaporation of brine. We could not manufacture salt for a single day were it not for the utilization of this refuse. The history of the manufacture of salt at Manistee is that it has been done entirely in connection with the lumber business in the way we have stated, and as soon as a mill has stopped making lumber, the evaporation of salt in connection with the business has ceased. One company here undertook to evaporate the brine by the use of coal, but they found that they could not pay expenses and soon stopped it.

We are organized under the Manufacturing Act, and not under the Mining Act. One of our stockholders induced the Attorney General to start a suit against us a little more than a year ago to stop our making salt, his contention being that it was a mining process and that being organized under the Manufacturing Act, we had no right to make salt under our charter. The state was beaten in the circuit court and appealed to the supreme court, which sustained our contention and held that we could continue to make salt in the way we are making it under the Manufacturing Company Act. You will find this case reported in Vol. 17 of the Detroit Legal News, page 1218.

We are obliged to make reports to the State Salt Inspector of our salt business, which we do regularly, and these reports are published annually by the State Salt Inspector.

We may add that we have submitted this matter to our counsel, Wilson, Wilson & Rice, of Grand Rapids, and they have written us that they have examined the Act under which you are asking for these statements, and that in their opinion, our salt business does not come within the purview of that Act, and we trust that with this explanation of the method of the manufacture of salt by us, you will agree with them. If we can give you any further information, please advise us.

Yours truly,
(Signed) The Buckley & Douglas Lumber Co.
By T. J. Elton, Secretary.

The definiteness with which this position was stated in the above letter impressed me that it would be necessary to submit the matter to your Board to determine whether it was desirable to force the companies taking such a position to furnish reports to the Appraiser of Mines and in a report to your Board of July 1st, in a letter addressed to Mr. Shields, I quoted the letter from Buckley & Douglas Lumber Company and stated that, as far as I could see, they were right. I quote one or two paragraphs from my report of that date:

"I submit these considerations in order that your Board may decide rather an important question about the conduct of my work. Many of the companies of lower Michigan expressed so much surprise at being classed as mining companies that they answered our circulars simply by stating that they were not doing any mining. If we are to compel them to turn in satisfactory reports, it will be necessary to go after them energetically. In the case of coal, I think it is plain that we should do this. In the other cases mentioned, it is far from plain.

The line of action I am disposed to recommend is simply to continue what we are doing, namely, get what information we can about these various enterprises. Wherever we succeed in getting satisfactory information about a salt or cement company that is so much to the good. Our report so far as can be judged at present will probably be that such concerns should be appraised on a manufacturing basis. I take it that a report of this kind will cover the requirements of the act."

So far as I know no steps were taken by your Board to indicate any dissent from the position outlined at that date, and as time went on it became more and more evident that the position was a correct one.

I asked Dr. Chance and Professor Cook to report to me their conclusions on the same subject, when they had finished their investigation and I append the reports of both these gentlemen.

The following is a summary report by Mr. C. W. Cook:

"July 31, 1911.

Mr. J. R. Finlay, Appraiser of Mines, Houghton, Michigan:

My Dear Sir:—My investigation of the salt, cement and limestone properties of the State has led to the following conclusion regarding the appraisal of the same.

1. That the presence of salt gives no additional value to lands because:
    (a) The supply is practically unlimited (see preliminary report.)
    (b) The method of obtaining the salt (except in the case of the shaft at Oakwood) that is by the formation of an artificial brine, does not permit the determination of whether the salt comes from the company's lands or adjoining lands.
    (c) It is the plant which gives the value to the salt.
    (d) It is only under exceptionally favorable conditions (such as the utilization of exhaust steam) that common salt (in counter distinction to table salt) can be produced at a profit.
2. That no valuation can be placed upon cement materials because:
    (a) There is no basis for appraisal inasmuch as there is no market for the lands.
    (b) The possible available reserves are far in excess of any possible demand.
    (c) Any increased value which the lands may possess must be due to the presence of a mill to utilize the materials. As shown by the reports on the various plants, practically none of the companies have been able to pay interest on investment in equipment in the last three years and, therefore, little if any, value can be placed upon the raw materials. That these conditions are quite certain to continue follows from the fact that the market which the Michigan mills can serve is extremely limited, while their production is far in excess of the demand. In addition to which, they must suffer competition with mills in adjacent states.
3. That the presence of limestone gives no additional value to land. In Alpena county thousands of limestone lands can be purchased at five to fifteen dollars an acre. In Monroe county, as shown in the report on the Shore Line Stone Company, limestone lands do not command any advance in price over lands for farming.

Respectfully yours,

CHAS. W. COOK."

MARL, LIMESTONE, GYPSUM AND SALT.

BY H. M. CHANCE.

Philadelphia, Pa., August 12, 1911.

Mr. J. R. Finlay, Appraiser of Mines, Board of State Tax Commissioners, Lansing, Michigan:

Dear Sir:—I have examined the material collected by Prof. Chas. W. Cook, relating to the manufacture of Portland Cement in Michigan, and have tabulated the statistics of production, and of the costs and selling prices per barrel during the last three years.

I find that nine companies have made complete returns of their output for the years 1908, 1909 and 1910, as follows:

1908	2,045,393
1909	2,596,375
1910	3,064,889
Total	7,706,657

Of these nine companies, seven companies also made complete returns of the cost per barrel of manufacture and of the selling price per barrel.

	Output, bbls.	Cost.	Receipts.
1908	1,645,134	$1,469,307	$1,517,608
1909	1,889,197	1,485,794	1,520,081
1910	2,006,266	1,705,924	1,876,035
Total	5,540,597	$4,661,025	$4,913,724
Average of three years, per bbl		84.1	88.7

The returns showing the capital invested in plant and improvements are quite incomplete, only six companies making any returns for any of these items and the same is true also of statements covering the amount invested by these several companies in the purchase of lands containing marl, limestone, shale and clay.

Some of these companies at the time of incorporation purchased lands and lakes, containing deposits of marl, at very high prices, and some of these companies have exhausted the marl from a considerable portion of the property so purchased, and have written off a large portion of the original cost as depreciation in value of the lands due to the removal or exhaustion of the deposits.

I do not think we can predicate values for any of these properties based upon the prices which such companies may have originally paid for the lands, even when a large portion of such original purchase price has been written off as depreciation, for the reason that the present money value of the property does not necessarily bear any relation to the prices paid at the time of purchase, the reason for this appearing evident upon an analysis of the situation from a manufacturing standpoint.

While I am not intimately conversant with the details of the manufacture and operation of factories manufacturing Portland cement. I have been in close touch with the development of the industry from its inception in Pennsylvania many years ago, and I believe that the conditions in Michigan do not differ materially from those in other states where Portland Cement is being manufactured at present.

Michigan has no natural Portland Cement rock, that is, no material similar to the natural cement rock of Pennsylvania, New York and some other states. Natural cement rock is an impure limestone, in which the impurities, consisting principally of alumina, iron and silica, are nearly in the right proportions required for the manufacture of Portland cement.

Where no natural cement stone is available, Portland cement is made by using any materials which contain these ingredients, and which can be mixed in the proper proportions to produce a mixture of the right chemical composition.

For this purpose any material that contains a large percentage of lime, such as limestone, marble, shells, or marl may be used, and the deficiency in alumina and silica can be supplied by the addition of clay, mud, slate, shale, quartz, sand, sandstone or other materials.

As limestone, clay, mud, shale, sand and slate are plentiful in almost all parts of the world, being among the most common of the formations that form the earth's outer crust, Portland cement may be manufactured in almost any desired locality. It is, however, desirable or necessary that the materials used should not contain more than a very small percentage of magnesia, and as magnesia is present in considerable quantity in many deposits of limestone, this requirement restricts the manufacture to those localities where limestone containing very little magnesia can be had; but as suitable limestone is available in enormous quantities at an unlimited number of localities in the United States, this restriction practically does not limit the location of Portland cement works to any particular districts or states.

In addition to these natural products, it has been found possible to use slag (cinder) from blast furnaces for the manufacture of Portland cement, the slag being ground and mixed with lime (and possibly clay) to make a mixture of the required composition.

In searching for raw materials for the manufacture of Portland cement, at an early stage in the development of the industry, it was recognized that the deposits of marl in Michigan and elsewhere might advantageously be used in place of limestone, and it was thought that the softness of the material would greatly cheapen the cost of manufacture, by substituting the cost of excavation of the marl for the cost of quarrying limestone, and by reducing the cost of grinding and mixing the ingredients. Following the general belief in these arguments, lands and lakes containing deposits of marl were eagerly sought, company after company was organized to manufacture cement from them, and properties containing such deposits were bought and sold at very high prices.

In the course of a few years of practical experience in the manufacture of cement from these deposits, it was found that in many cases factories using marl had little if any advantage over those using limestone. The large quantity of water contained in the marl, which must be evaporated, involves an expense perhaps equal to the difference between the costs of grinding marl and limestone, the difficulties in excavating and handling the marl were greater than was anticipated, and in many cases the percentage of impurities, of organic matter, and other objectionable constitutents was large and troublesome. As a result of these unfavorable experiences with marl deposits, some of the companies abandoned the use of marl and remodeled their plants to use limesome. The experienee of other companies using marl was that they could not manufacture cement any cheaper than their competitors who were using limestone.

It seems, therefore, safe to conclude that as a material for the manufacture of cement, marl (which may be regarded as an unsolidified limestone) is no more valuable acre for acre, or ton for ton, than limestone.

VALUE OF MARL AND LIMESTONE LAND.

As experience in cement making has shown that marl is not inherently or intrinsically more valuable than limestone, the value of each for cement making will be subject to the same limitations. It is a well known fact that the mere presence of limestone seldom increases the value of land. In a region well supplied with limestone, and in which the limestone, as such, generally has no market value separable from the value of the surface, if a deposit of limestone of good quality and of relatively small area is in close proximity to a city, to a chemical works or other large consumer, and exists under conditions especially favorable to cheap quarrying, then such property becomes valuable by reason of the presence of limestone. Conditions favorable to cheap quarrying may be, height of the deposit above the surrounding country sufficient to permit of the opening of a high quarry face and a self draining pit, or small quantity of soil or other surface material to be removed in opening and working the quarry, or such composition of the stone as will permit of the use of all of it, either for making quick-lime, or as building stone, railroad ballast, road macadam, for concrete construction or for cement or chemical manufactures. But when limestone of such character and conditions exists over a large area, or throughout a district, the supply being greatly in excess of any possible demand, lands containing it are not salable at higher prices than those which do not contain it.

Hence when lands containing an abundant raw material such as limestone, shale, clay or sand become valuable and salable because of the presence of the material and of physical conditions favorable to a cheap excavation, the question arises as to whether the purchaser is paying for the material or for the advantage of location and ease of extraction and transportation to market. It seems to me not illogical to adopt the latter views and unless some special advantages can be shown, to conclude that the only method by which such property can be appraised must be based upon the value which can directly be traced to the reduced cost of extraction and transportation. For example, if a limestone

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